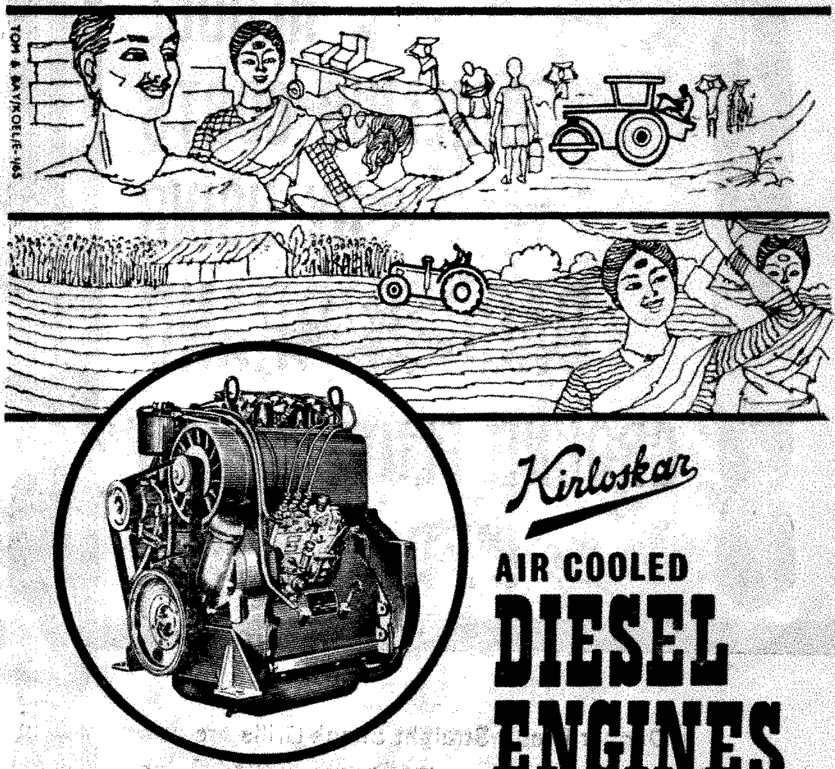

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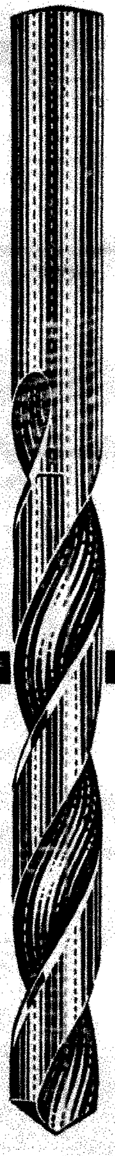

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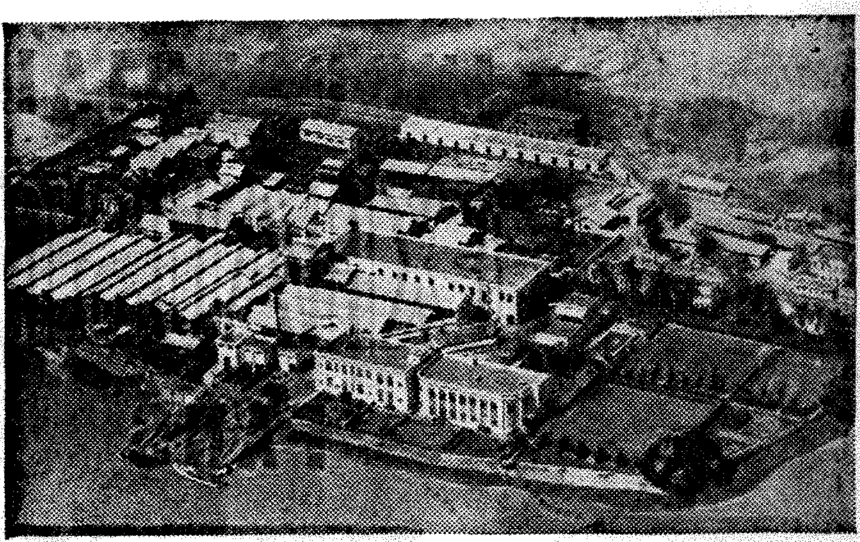

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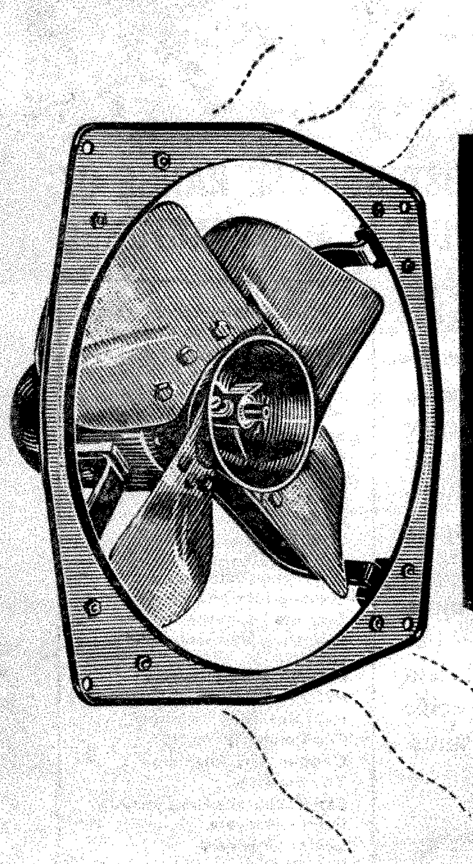

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THE BULLETIN
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Proceedings of the Seminar on
'TECHNICAL EDUCATION AND ITS DEVLOPMENT (1966-81)'

Held concurrently with the 45th Annual Convention
at Lucknow, February 19-23, 1965

PREFACE

This volume of the *Proceedings of the Seminar on 'Technical' Education and Its Development (1966-81)'* is the outcome of an invitation received by the Institution from the Ministry of Education early in 1964 to offer suggestions on the perspective plan of development of technical education during the next fifteen years. The Ministry had set up a Central Planning Group (now the Education Commission) to study educational patterns and to recommend a development policy and had indicated it would welcome the Institution's views on technical education.

The matter was discussed by the Council of the Institution at their 435th Meeting held in Bangalore with Dr. T. Sen, President for 1963-64, in the Chair. Dr. Sen himself was a member of the Group, and is a member of the Commission now, and this fact reinforced the Council's decision taken at that meeting that the Institution should organize a Seminar on technical education on a nationwide scale under the auspices of the Engineering Education Committee of the Council, of which I happened to be the Convenor. The Council further asked me to become the Convenor of the Seminar and organize it in such a manner that discussions were held as far as possible at all the Local Centres of the Institution before the 45th Annual Convention of the Institution in Lucknow in February 1965, so that all these regional discussions could lead up to an all-India Seminar at the Convention.

It was particularly appropriate that the Institution should take such an active part in the reorientation of technical education, as it had members on its Roll from every single branch of engineering and working in every phase of engineering activity. Its Corporate Members were drawn from planners in high public offices, directors of corporations and companies, professors in institutes of higher learning and engineering universities, research directors, chief executives of public and private projects, industrial consultants, consulting engineers, and indeed every other engineering occupation. It had moreover well over 40,000 Students on its Roll, most of whom were striving to obtain engineering qualification of the degree level through its examinations, an additional fact which made it vitally interested in the development of technical education.

Suggestions for topics of discussion were invited, and when these were finally compiled, it was realized that such was the interest shown by the members and even by

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The Preface, the Recommendations and the Report printed in these pages of this *Bulletin* for information of members, form a part of the *Proceedings of the Seminar on Technical Education and Its Development (1966-81)*', published by the Institution following the Seminar held in February 1965. Prof. N. S. Govinda Rao, President and Shri B. Seshadri, Secretary, of the Institution, were invited to give, on behalf of the Institution, evidence before the Education Commission at New Delhi on the suggestions for development of technical education contained in the *Proceedings*, which they did on August 17, 1965.

others who were not members, that the whole vast range of problems confronting technical education was covered. The next step was to invite papers for the Seminar, and here again the response was overwhelming.

Discussions were held at a number of Local Centres of the Institution despite the short notice, and recommendations and suggestions were received from the Andhra Pradesh, Bengal, Delhi, Kerala, Orissa and Punjab Centres for consideration at the all-India Seminar.

Before the 45th Annual Convention of the Institution, the Council honoured me by electing me President of the Institution for 1964-65, in succession to Dr. Sen. I became therefore dually connected with the Seminar, as its Convenor and as President of the Institution.

The Seminar was held in Lucknow concurrently with the 45th Annual Convention, on the four days, 19th, 20th, 22nd and 23rd February, 1965. It was inaugurated by Shri Kailash Prakash, Education Minister of Uttar Pradesh, who very appropriately stressed the importance of technical education for our developing country, and spoke words of encouragement to the Institution in its efforts to assist the Government by the submission of its views. Earlier, at the Inaugural Session of the Convention, I had also made technical education the theme of my Presidential Address, and Shri M. C. Chagla, Union Minister of Education, while inaugurating the Convention had referred generously to it and inspired us with spirit and hope in the field of technical education.

The Seminar was held in four Sessions. The Chairs at these Sessions were successively taken by Brig. S. K. Bose, Director of the Indian Institute of Technology, Bombay; Shri G. Pande, Vice-Chancellor of the Roorkee University; Shri G. K. Chandiramani, Joint Secretary to the Union Ministry of Education; and Prof. S. Rajaraman, Director of Technical Education, Kerala. General Reports on the papers presented under each Session were respectively presented by Dr. H. C. Visvesvaraya, Deputy Director, Indian Standards Institution; Prof. R. S. Chaturvedi, Head of the Civil Engineering Department, Roorkee University; Prof. G. S. Ramaswamy, Deputy Director, Central Building Research Institute, Roorkee and Prof. A. Lakshmanaswamy, Principal, Government Engineering College, Jabalpur.

In this *Proceedings* are printed the full texts of a selected number of papers only, both to conserve space and because they directly illustrate and amplify the Recommendations which form Part I of the *Proceedings*. However, the abstracts of all other papers accepted for presentation at the Seminar are also included. Further, the General Reports and the discussions at the various Sessions are also printed.

The *Proceedings* commence with Part I on Recommendations followed by Part II which is in the form of a Report on the varied apects of technical education and comprising 27 chapters. The Recommendations are a summarized version of the Report and are designed to focus attention on the most important features covered in each chapter of the Report. All opinion expressed in these two Parts should be taken as personal to myself, and do not commit the Institution in any way. While making these comments and expressing views, however, I have taken as far as possible into consideration, in the time that was available before me, the different views expressed in the papers, during the discussions at the Seminar, and in the summaries of the meetings held at the Local Centres. I believe they may well contain the consensus of views expressed by the members as a whole, but a Report of this length and nature has necessarily to be a single man's job, bearing in mind the restrictions imposed by time and the difficulties of further consultation. These views are put before the Commission in sincerity and seriousness as an expression of the efforts of the Institution conveyed through its President.

In conclusion, I wish to place on record the valuable help I have received from Shri B. Seshadri, Secretary of the Institution, in organizing the Seminar and in the preparation of the Report. Shri B. R. Subramanyam, Assistant Secretary (Technical), and his staff have also contributed largely to the success of the Seminar and in the publication of the *Proceedings*.

N. S. Govinda Rao
President

Calcutta, June 1965.

PART I—RECOMMENDATIONS

CHAPTER I

INTRODUCTION—METHOD FOLLOWED IN WRITING THE REPORT

1. Any policy on planning for education has necessarily to take into consideration (*a*) the history of the development of technical education, and (*b*) the social and economic conditions as they exist today.

2. Every national activity whether it is in the field of education, technical development, or any other, should be linked to each of the others to achieve the declared objectives of the Government. Every national activity should be construed as but one more link in the long chain forged for lifting high the standards of living. Development of technical education is not an end in itself but *is only a means* to achieve the ultimate end, that is, the raising of standards of living through the use of modern science and technology.

3. Every policy on education should be dynamic in character. In the present state of the country, everyone is in need of more food, clothing, housing and all that makes living more comfortable. People have suffered from poverty for centuries. Technical education which will lead to gainful employment is the primary need of the hour. Fifteen years hence, when the standard of living has increased a little, there should be a shift in policy on technical education to give more emphasis to science than what has to be done now. Probably a few decades thence when automation may reign supreme in technology, when people may have more hours of leisure than hours of work, the policy on technical education may have to be shifted to give accent to the humanities so that the leisure hours are utilised in a way which will promote individual happiness and encourage harmonious growth of society.

4. The scientific way of thinking should always be encouraged. It should not be confused with development of science and scientific research in its fundamental and applied aspects. Scientific research thrives best in an environment where technology has already developed sufficiently to try new processes to help in making instruments and tools for research, and to enable scientists to plan and fabricate all the equipment they require. Design and development units should come first in our production units, before enlarging efforts to increase pure scientific research in the country. A decade or two later, emphasis should be shifted to applied and pure science research so as to secure a lead in the production of newer and/or better products from available natural resources. This does not mean that we should not encourage science research in its fundamental aspects. Only, the emphasis for the present should be in the applied field of technology.

CHAPTER II

HISTORICAL BACKGROUND

1. Engineering is the great constructive profession, which benefits the world by things made and done, and *not merely talked about*.

2. Technology is the father of science, *e.g.*, water wheels were in existence before there was any formal theory of hydraulics, the aeroplane was first flown before theories of flight were developed, and so on.

3. *Science is different from scientific way of thinking.*

4. Engineering is both a science and an art. It involves a sound knowledge of technology and a knowledge of management of men.

CHAPTER III

SOCIAL AND ECONOMIC BACKGROUND : DEFICIENCIES IN THE PRESENT SYSTEM

1. The country now suffers from (*a*) low levels of productivity, (*b*) low national and per capita income and standards of living, (*c*) a high proportion of the population being engaged in agriculture, (*d*) the existence of large scale unemployment and under-employment, (*e*) dependence on more advanced countries for equipment and technical knowledge, and (*f*) inadequate rate of economic growth. Technical education should aid in reducing these factors which inhibit technical development.

2. The deficiencies in the present technical educational system have been pointed out in all the papers referred to in the Appendix to this chapter in the Report.

3. The policy should be so framed as to make optimum use of available resources by reorienting the present pattern of technical education itself rather than by attempting to revolutionise the entire system of technical education.

CHAPTER IV

PURPOSE AND AIMS OF TECHNICAL EDUCATION

1. Technical education should aim at training well educated and cultured citizens equipped with a knowledge of modern science and technology, capable of skilled work, physically fit and healthy, and imbued with a spirit of patriotism. They should be able to develop pursuits which will give them happiness and at the same time establish harmony and peace in their environment.

2. Although self-sufficiency should be the aim at each stage of technical education, preference should invariably be given to those who have covered one stage for admission to the next higher stage. Curricula for studies should be drawn up with this end in view. This measure will result in giving new dimensions of respectability to craft and other technical education where there are none now. When once it is known that preference is given in admission to those who have already acquired a skill, almost all boys will be attracted towards technical education so that the best amongst them can always be selected from the previous stage to the next higher stage. Those not selected for admission can earn their livelihood by practising the craft they have already acquired. The frustration which the S.S.L.C. and P.U.C. boys now feel when denied admission to technical courses and the anti-social traits they develop towards the community in

general and the Government in particular will not then be there to the extent it is now prevailing.

3. Detailed information on this subject is given in all the papers referred to in the Appendix to this chapter in the Report.

CHAPTER V

STAGES IN TECHNICAL EDUCATION

1. At present, activities in spreading technical education should be confined to the following :

- (*a*) Giving technical bias to education at all levels, specially at the elementary school stage, so that mental and physical work supplement each other. Manual work will then gain new dimensions of respectability.
- (*b*) Training of skilled craftsmen.
- (*c*) Technicians.
- (*d*) Erection and maintenance engineers.
- (*e*) Industrialist engineers.
- (*f*) Design and development engineers.
- (*g*) Engineer-scientists.
- (*h*) Management engineers.
- (*i*) Extension activities to increase productivity amongst carpenters, blacksmiths, land tillers, and other craftsmen, who are mostly illiterate, in the towns and villages.
- (*j*) Technical education for women at home.
- (*k*) Extension work for those already in employment.
- (*l*) Technical education for the physically handicapped.
- (*m*) Technical education of specialised types such as for engineers to design and make surgical instruments for medical men, to design and fabricate equipment for sport, games and toys, to increase sales promotion in and outside India, to design and fabricate equipment for museums, exhibitions, etc.
- (*n*) Technical education for military requirements.

CHAPTER VI

TECHNICAL BIAS TO GENERAL EDUCATION IN ELEMENTARY AND SECONDARY SCHOOLS

1. In nursery schools (age 3-6 years), children should be taught to respect work. A lot of time should be given to singing, dancing, drawing, model making, and playing with toys. Film shows and puppet shows should also be used.

2. In the secondary schools (6-16 years), the syllabi that are being presently followed are generally satisfactory on the theoretical side. Rewriting of the text-books in subjects like mathematics, physics, chemistry and drawing have been suggested so as to bring the school closer to actual life.

3. It should be compulsory for the teachers to set apart two half-days in the week to take out teams of boys on excursions for the observation of production processes. This may consist in systematic observation, week by week, of agricultural farming and processing methods, or manufacture of products in a factory, or construction of buildings, starting from their foundation to their completion, and such others. At the end of each term, the boys should be encouraged to write reports of what they have seen.

4. The pattern of syllabi used in Czechoslovakia may be adopted for IX, X and XI standards, the syllabus for the VIII standard being kept as it is, These students coming out from higher secondary schools will be eminently suitable for admission to technical courses in universities.

CHAPTER VII

CRAFTSMEN TRAINING

1. It is generally seen that in underdeveloped countries, heavy emphasis is placed on development of technology in education. Studying conditions in our own country, the Russian pattern of four years training after the VII standard (P.U.C. standard level) seems to be suitable with slight modifications, as it is a scheme which has good balance between the humanities, science and technology.

2. A list of 50 trades have been given only as an example. More than 500 can be listed. Students should be taught *only one craft* during the four years of training. The emphasis should be on acquirement of expertness in skill and *not on acquiring knowledge.*

3. The success of the craftsmen training scheme *depends entirely* on the scope given for higher training after completion of this course. For this purpose, *preference should be given* to these craftsmen in the matter of admission to both diploma and degree courses in engineering. *It is only in this way that the best students will be attracted.*

4. The existing Industrial Training Institutes may be converted to Higher Secondary Technical Schools for training craftsmen.

5. The syllabi and the duration of courses leading to a diploma or to a first degree in engineering have to be quite different from those given to students entering the technical institutions after completing the general S.S.L.C. or the higher secondary (P.U.C.) courses (see Chart I). Separate sections in the existing polytechnics and engineering colleges can be opened for these purposes. There can be a considerable number of common classes in many subjects between students undergoing courses with different syllabi for both diploma and degree conferments.

CHAPTER VIII

TECHNICIANS' TRAINING

1. At present, skilled craftsmen are generally illiterate. Hereafter, skilled craftsmen should be persons who have completed the VII standard. When education becomes free and compulsory up to the X standard (that is, the S.S.L.C. level), craftsmen can then be trained at a higher level as is done in most of the advanced countries. Till then there is necessity for two types of craftsmen, one the ordinary craftsman and another the technician who knows enough of the crafts to supervise the work of the craftsmen.

2. The aim of the training of technicians for the award of a diploma should be to produce craftsmen who have thorough familiarity with the operation and maintenance of all the equipment they have to handle coupled with an intimate knowledge of the knowhow of erecting them. *The diploma course should be considered as the continuation of the craftsmen course in a more intensified and enlarged form than as a condensed or a simplified version of the first degree course in engineering.*

3. The present diploma course is a failure as it does not give the students the knowledge necessary to take up design, planning and execution of projects as the degree holders are expected to do. These students do not also have that intimate knowledge of the drafts which can earn the respect of the craftsmen working under them. The result is, at least for the first few years of their service and till they pick up work by self-study, they are treated with contempt by their superintendents as well as by the workers under them.

4. The existing polytechnics may be used for offering these new types of diploma courses. The present teachers have to be given suitable training specially on the practical side. The list of courses can run to over a hundred.

5. The success of the diploma courses depends on four factors : (*a*) the courses offered should be more diverse and better linked with the requirements of the industry or the project where the student is to work ; (*b*) preferences should be given to these boys in the matter of admission to the degree courses ; (*c*) a separate scheme and syllabi for the courses should be drawn up for training these boys for the degree courses ; and (*d*) separate syllabi should be devised so that the three streams of students completing the VII standard of education are enabled to work their way to diploma courses (see Chart I).

6. For the first stream, the duration of the course should be of three years for those who have completed their S.S.L.C. course (X standard). For the second stream, it can be of two and a half years duration for those who have passed out of the four-year Higher Secondary Technical School course, the first half-year being spent in teaching the basic sciences and the language which may not have been adequately covered earlier. The third stream will comprise students who join factories after completing the VII standard and have undergone a three-year apprentice school course in a factory. For these, the diploma course will have to be of four years duration, the first two years being devoted mostly to the study of the sciences and the language. These courses may be sandwich courses.

CHAPTER IX

ERECTION AND MAINTENANCE ENGINEERS : FIRST DEGREE COURSE IN ENGINEERING

1. The first degree course in engineering is primarily meant to train erection and maintenance engineers. These are meant to specialize in construction, management and operation of large engineering projects. While they will also be taught design, it will not be of the high standard necessary for creating a specialist. These engineers are expected to work individually or in a team with others. Training for these will have to be broad-based with accent on the practical side.

2. This should also be the basic degree which should lead to training of specialists.

3. In the U.S.S.R., training even at the first degree level is highly specialized, for example, at one time, there were 111 specialities in just one branch of mechanical engineering, that of machine design. There are 16 institutes which teach only machine construction, machine tools and tools. In the U.K., it is thought that technological education is in need of changes, specially at the degree level. It is felt in Britain that comparative statistics show that within the total field of science and technology, less emphasis is given to technology and more to pure science than in any of the other countries. In India, a middle course avoiding both the extremes will have to be followed.

4. The present first degree course in engineering is very well balanced between the requirements of the humanities, science and technology. These courses have been evolved after decades of experience and they may be generally retained in their present form. There are only two defects :

(*a*) Not enough emphasis has been given to teaching the practical side of the profession. Though this need not be as intensive as in the case of doctors in the medical profession, the emphasis now given to practical training is not enough ; and (*b*) in view of the vast strides in technical development being made in the country now and the likely step-up in the tempo of such activities in the future, the present number of courses offered for the first degree is too small and is very wide-based. They are so general that students, for example in civil engineering, have no chance of making use of more than 30 per cent of their knowledge in many subjects of civil engineering when they enter the profession in a particular field.

5. The number of courses to be offered for the first degree should be enlarged manyfold. Each course should cover only broad areas, no attempt being made at specialization in narrow fields, *e.g.*, the present Civil Engineering course can be split up into (*a*) Transport and Communication Engineering ; (*b*) Construction Engineering ; and (*c*) Water Resources Engineering.

6. Four streams of entry to the first degree course in engineering (see Chart I) may be introduced. The syllabi for these four courses shall necessarily have to be different. For the first stream, the course has to be of five years duration for those passing out of the Higher Secondary Technical Schools. The second stream is from the Higher Secondary Technical Schools, and the course will be of five years duration.

The third stream is from those who have taken a diploma course, and the duration of the course may be three and a half years. The fourth stream is described in para 11.2 describing the industrialist engineer. Each stream will follow its own syllabi and curricula, though the total quantum of knowledge acquired by the students will be the same at the end of the course.

CHAPTER X

DESIGN AND DEVELOPMENT ENGINEERS : POST-GRADUATE COURSES IN ENGINEERING

1. In our country, boys do not grow in the same type of technical environment as in highly developed countries. It is therefore necessary that the first degree course should aim at creating this technical interest in the students. Highly specialised jobs are very difficult to get. It is next to impossible to make a living placing a reliance on learning one particular narrow speciality in engineering. They may have to change jobs from one speciality to another. Taking all these factors into consideration, it is desirable to leave the present five-year integrated course in its present form.

2. One almost revolutionary change has been suggested to keep in step with the present technological development that has taken place during these 18 years. That is, the very broad fields of civil, mechanical, electrical and their existing branches of engineering have been proposed to be broken up into two or more broad areas of study. This may be further reviewed 15 years hence, and in the circumstances existing then, the scheme of these courses may be further revised.

3. At the first degree level, the student is expected to learn a number of basic facts in engineering and apply them mostly in the design and execution of projects. The second degree should not be construed as a continuation of the first degree level as has been done in most universities in the U.S.A. and a few other countries. The objective to be achieved is to increase depth in thinking, instead of gathering a wide range of information mostly in fundamentals in a variety of subjects as is done at the first degree This intensity in thinking is sought to be achieved in a variety of ways. The student is encouraged to pursue his studies in only a limited field of knowledge. He is to discuss them in seminars, in discussion groups, and in oral examinations held by his guide at frequent intervals. He is to write papers of the review type as well as original contributions for publication. He may work out various possible alternatives in a design project and write a discussion as to why he thinks one of them is better than the others.

4. The personality of the guide is a very important factor in shaping the mind of the student. He should encourage the student to think for himself and question critically the various topics he reads in his text-books and technical journals and hears at seminars which he attends. Actually, at post-graduate level, specially at the Ph. D. level, the master (*'guru'*) transfers his own personality, stature, maturity in thinking, and originality of approach to given problem to his students by close association. This training of the mind of the student can be achieved both through working out critically

design and development projects, and by working intensively on an investigation problem in a very narrow field of speciality. At present, this country is in need of design and development engineers, small-scale industrialists, management engineers, and consulting engineers in large numbers. These are to be trained in critical and intensive thinking through offering scope to show originality of approach in design and development projects, or in solving management 'cases'.

5. This country also needs research workers. It is better to start even from now in training only the best types. At the end of his course, a student should not only have made a substantial original contribution to the knowledge of the subject of his investigations but should also be capable of guiding others in research. The aim should therefore be to initiate only Ph. D. courses in research. This subject is further discussed in Chapter XII.

6. As mentioned in para 10.1, post-graduate courses for design and development engineers should be of two years duration, the first year being devoted mostly to learning the basic science and engineering subjects relevant to the narrow field of speciality. The second year should be devoted both to the studies necessary for preparing the design project and the preparation of the project itself. The project may be prepared in the college and/or in the factory engaged in work allied to the speciality. The project should be defended before a Board of Examiners drawn partly from the universities and partly from industry.

7. The curricula for the courses may follow largely the Russian pattern as indicated in para 10.3. As most of the basic subjects taught in a five-year course in Russia will also have been taught here, two years are more than enough to cover the subjects of narrow speciality not covered in the first degree course.

8. Teaching of the basic science subjects like physics, mathematics and chemistry should be completely reoriented according to the Russian pattern discussed in para 10.4

9. Instead of starting separate institutes for each speciality, we may act on the recommendations of the Robbins Committee (U.K.) that post-graduate education should be developed mostly in a few first-rate institutions. All the Higher Institutes of Technology (I.I.T.s) and all the Regional Engineering Colleges should offer as many of the specialities as they can. Russia has listed more than 500 of them.

10. We may also act on another recommendation of the Robbins Committee that a few first-rate institutions should be developed whose main activity will be post-graduate work. All the Higher Institutes of Tehnology (I.I.T.s) and other first-rate institutions should convert themselves primarily into post-graduate institutions with at least 75 per cent of their students devoting themselves to post-graduate work. As the number of these first grade institutions to the total existing in the country (25 in 120) is very small, at least 75 per cent of the students in the I.I.T.s and 50 per cent of the students in the Regional Engineering Colleges should work for post-graduate conferments. All the I.I.T.s should also train students for Ph.D., Dr. Eng., and such other courses also. Working for doctoral conferments in the Regional Engineering Colleges as also other engineering colleges should be encouraged.

CHAPTER XI

INDUSTRIALIST ENGINEERS : POST-GRADUATE AND GRADUATE COURSES

1. The tempo of the present rate of industrial development can be substantially raised, if a *massive effort* is made to start small-scale industries all over the country both in urban and rural areas. One of the difficulties is the shortage of technical men who have the 'knowhow' of starting such industries. It is imperative that courses are opened to train such men.

2. Of the types of course required, one type should be at the post-graduate level. Those who have a first degree in engineering or an equivalent qualification like the passing of Sections A & B of the Associate Membership Examination of the Institution of Engineers (India) should be given a post-graduate degree course in Industrial Engineering extending over two years. The first year will be devoted to gaining all the knowledge necessary for running a small-scale industry like production engineering, labour management and industrial psychology, economics and financing of business, cost accounting and budgetary control, materials purchase and handling, publicity, packing and advertising, planning and layout of factory buildings, power supply and distribution, and such other subjects. The second year will be devoted entirely to the study of a narrow speciality in which business is to be started, *e.g.*, ferrous or non-ferrous foundry practice, precision optical instruments manufacture, manufacture of pressure gauges and control instruments, small horse-power motors, prestressed concrete beams, etc. The thesis for this course should consist of a complete project report for starting an industry in the speciality of the student's choice. It should be defended before a Board of Examiners. This is the M.E. degree course B in Chart 2.

3. The second type of course is a post-diploma course leading to the first degree in engineering. It can be of three and a half years duration as in the case of other types of diploma students working for a degree. The first two years will be devoted to the study of a narrow speciality in which business is to be started by the student. At the end of these two years, he will have grown as to have obtained the maturity necessary for appreciating the subjects needed for starting an industry. He should study the same subjects which are prescribed for the post-graduate students in this subject for one year. The last six months of the course should be devoted to the preparation of a thesis which should be a complete project for starting an industry in his speciality. This is first degree course D in Chart I.

4. It is no doubt true that there are no such courses anywhere in the world. That should be no reason why they should not be started in this country. They should be conducted both at the I.I.T.s and the Regional Engineering Colleges.

CHAPTER XII

ENGINEER-SCIENTISTS : RESEARCH COURSES AT DOCTORATE AND POST-GRADUATE LEVELS

1. For reasons already discussed, training of research workers should be at the highest levels. The aim should be to train persons who can not only do original work

of a high order but are also capable of guiding others in research. These are the persons who can give a lead to technological development in one of the following ways : (*a*) by finding a new application to technological development by using the result of an investigation in the basic science (the Ph. D. award may be given for this type of work); (*b*) by making a substantial addition to our knowledge of engineering using the result of investigations made in the behaviour of engineering structures or their components under specified field and/or laboratory conditions (the D. Eng. award may be given for this type of work); (*c*) by making out an ingenioius design of an equipment or a project based on years of experience in working in the field and/or laboratory (the D. Tech. may be awarded for this type of work).

2. Different doctorate awards, denoting the stream through which the degree was obtained, should be given. In this manner, it will be possible to secure a lead in technical development by all possible means.

3. The research course leading to the Ph.D. award is meant to bridge the gap between pure and applied science. There are no special institutes of this type anywhere in the world except Russia and Germany. Even in these countries, the research institutes meant for this purpose start their training at the undergraduate level. There can be no two opinions about the need of such research in this country. Starting undergraduate courses of an absolutely new pattern will throw out of gear the existing pattern of education. This will merely create chaos without attaining the objective.

4. The University Grants Commission has rightly started advanced centres of research in several universities. Their functions can be easily enlarged as we have already a nucleus to start with. We can recruit graduates in science (B.Sc.) and offer them a six-year integrated course leading to a Ph. D. award. The first three years can be devoted to the study of subjects similar to those studied both at the undergraduate and post-graduate levels in Russian universities and institutes which have facilities in the subjects which bridge the gap between science and engineering. The last two years should be devoted to research in one particular topic of interest either to the professor or to the student. The standard of Ph.D can be the same as in the U.S.A., the thesis being only a partial requirement, emphasis being on intensive study of the subjects allied to the thesis. Unlik the Russian pattern, there should be a greater content of basic engineering in the course like Engineering Drawing and Workshop Practice and Technology. Students who have completed a Master's degree in science can also take up this course, the duration being reduced to four years.

5. In science, we already have a few institutes devoted to particular fields of research like Sir C. V. Raman's Institute, the Tata Institute of Fundamental Research, and Ramanujam's Institute of Mathematics. It is desirable to build up, in course of time, a university devoted entirely to research in fields of pure science, in the common areas of science and technology, science and medicine, science and agriculture, and in all other areas which bridge the gap between pure science and the other professions based on the application of a knowledge of science.

6. The second stream is the one leading to the award of a D. Eng. degree. This can be an integrated course of five years for those taking their first degree in engineering.

The first two years will be spent in studying the basic sciences, a foreign language, and a few engineering subjects. The last three years will be devoted to an intensive study of the subjects allied to the field of the student's investigations and the preparation of the thesis. A suitable curriculum for this integrated course has to be drawn up. For those who have a Master's degree in engineering, the course may be reduced to three years. The present M.E. courses are very well organised. There is no organised instruction for the D. Eng. course. This should be drawn up. The curriculum for this will have to be different from the curriculum in the integrated course of five years.

7. The third stream is the one leading to the award of the D. Tech. (Doctor of Technology) degree. This corresponds to an external degree of a university such as the London University. This is meant for those who have practised in the profession either as a teacher or as an executive for at least ten years and have gained a degree of maturity not generally found amongst freshmen from the colleges. A few extraordinary persons manage to retain alive their academic interest and also exhibit great ingenuity either in design or project planning work. Such persons should be encouraged to make their contributions to the development of technology in the country. As this is an external degree thrown open to any person who has a first degree or its equivalent in engineering, great care is necessary in framing the scheme of examinations. The number of written papers for the examintion has to be necessarily large. Each subject should have both a written paper and an oral examination. The standard expected of the thesis should be high and well defended before a duly constituted Board of Examiners. Study of a foreign language should be an essential requirement for this degree also.

8. All the Higher Institutes of Technology (I.I.T.s) and a few others of similar standard should engage themselves in preparing students both for the Ph.D. and D. Eng. degrees. They should also conduct examinations for the D. Tech, degree. Selected professors should be recognised in the various Regional Engineering Colleges and other engineering colleges in the counrty for guiding candidates for the doctorate awards.

9. As will be recommended in the succeeding chapters, the control and expenses in the way of salaries, capital and working costs, etc. of the departments recognised for preparing candidates for the doctorate awards should be fully met by the Ministry of Education. These Education Ministry Professors and those working in the I.I.T.s may form an All-India Cadre of Professors available for transfer if necessary from one institution to another.

10. In the U.S.S.R., the Academy of Sciences play a very large part in guiding post-graduate research. Many institutes are directly managed by them. Since education is a concurrent subject in our Constitution, unitary control is not feasible. It is also not necessary as there is no point in stifling academic freedom. What is, however, necessary is to ensure high standards and uniformity of standards amongst all institutes and colleges as far as possible. The only national institution of science and technology which does not work in severe isolation from industry and the general economic life of the people is the Institution of Engineers (India). Unlike the scientist,

the engineer comes in daily contact with the people in his professional work. The Institution has on its Roll academic persons well known for their work and of the highest calibre, Directors of National Laboratories and others conversant with requirements of the type of research problems necessary for technical development in the country, eminent consulting engineers some of whom are of international repute, industrialists who know all about requirements of industry and the associated problems, specially those of the technical 'knowhow' they are getting from their foreign collaborators, and many others. This Institution is the obvious choice for being entrusted with the responsibility of maintaining standards, drawing up periodically lists of areas in which research is necessary, and in ensuring fair and impartial recruitment of technical staff. It should be legally made obligatory to associate one or more representatives of the Institution at all oral and written examinations for the doctorate degree, and in the selection committees for the recruitment of Professors and other staff members who are to guide research for doctorate awards.

CHAPTER XIII

MANAGEMENT ENGINEERS AND PROJECT CONSULTANTS : POST-GRADUATE COURSE

1. Management engineers are the persons who have a knowledge of both technology and management. The post-graduate course in this respect is not meant for engineering graduates fresh from colleges. A certain amount of maturity is necessary for getting the full benefit of this course, coupled with actual experience in supervisory positions. Admission to the course should be limited to those who have at least a minimum of ten years experience in the profession. The course can be of two years duration, one year being devoted to the study of relevant subjects like principles of planning and layout of projects including preparation of project reports, industrial psychology, industrial economics, operational analysis, statistical quality control, cost accounting, labour management, and other allied subjects. The second year should be devoted entirely to the preparation of a project report of the same project in which the person is working with a detailed analysis of how he proposes to increase its efficiency in factors which are material for starting and working a project and selling its end products like capital formation, financing, materials purchase, stores labour organization, wages, machines, their layout and installation, etc.

2. There are already well established Institutes of Management. There is no necessity to open new courses. The present trend in thinking is that this subject is best taught in a separate institute, instead of in a department attached to a college.

CHAPTER XIV

PRACTICAL TRAINING AND APPRENTICE TRAINING

1. This work of apprentice training does not come strictly under the purview of the Ministry of Education. But then, this is one of the most important activities necessary for rapid development of technology and increase of productivity in the country.

This activity requires to be increased manyfold by the Ministry of Labour. Broadly, apprentice training can be of four categories.

2. First, there is *apprentice training for the uneducated* or who have just completed the first four years of compulsory education. At present, this type of apprentice, mostly in the villages or towns, gets attached to a senior workman. The amount learnt and degree of skill acquired by the apprentice depends on the understanding of his boss and his own natural aptitude to 'pick up the trade'. This system requires to be reorganized. Craft inspectors should be appointed to inspect the progress of these apprentices. Suitable legislation is also necessary to compel these boys to attend special schools. The duration of these apprenticeships may be of three years after which an examination for a Junior Skilled Workman's Certificate in a particular trade may be issued. There may be further Senior and Proficiency grades in these examinations, these being taken after intervals of two years each.

3. Next, the *crafts apprenticeships* may be for those who have completed seven years of school education and are employed in factories. They may learn a particular craft like fitter, turner, machinist, pattern maker, moulder, toolmaker, millwright, instrument maker, electrician, sheetmetal worker, and so on. Concurrently with the training received in the works, the apprentice should follow a course in an evening school either attached to the factory or run in the Industrial Training Institutes or in any local high school building. The course may last for three years and lead to the Junior Grade Craftsman's Certificate. There may be further grades at Senior and Proficiency levels at intervals of two years each. Training has to be under qualified craft inspectors appointed by the Central or State Governments.

4. *Engineering apprenticeships* are meant for those who are employed in factories after passing the X Standard or the S.S.L.C. Examination. After the completion of their training in the factory, they should be capable of working as assistants in the drawing office in the design and development section, or go out as salesmen of the products of the company. This course may also last for three years. During the evenings, these students should be coached to appear for the Studentship Examination of the Institution of Engineers (India) which is of the same standard as the first year B.Sc. course. Thus a way is paved for the ambitious few to become full fledged engineers in course of time by passing Sections A and B of the Associate Membership Examination of the Institution. Craft inspectors should supervise this training.

5. *Graduate practical training* is meant for those who have just passed out of the college. The object of this training is for the student to gain a knowledge of the potentialities of processes and skills rather than to acquire the skill himself. The duration of training should be 12 months. Legislation should be made, making it compulsory for every fresh graduate to register himself in an employment exchange before he can get employment either in the public or private sector. The training has to be under the supervision of a craft inspector appointed by the Central Government.

6. The graduate apprentice will be expected to submit a full report on the work he did during his training and pass an oral examination before a Board of Examiners, consisting of a representative from the factory in which he has taken the training, the

craft inspector or his nominee, and a person unconnected with both, preferably a nominee of an organization like the Institution of Engineers (India) at its Local Centre.

7. Graduates should be first recruited through the employment exchange and should not be allowed legally to start their career unless and until they have satisfactorily completed their practical training.

8. This training is unnecessary for those who wish to work for a post-graduate course. They too will have to undergo practical training before they are employed. The duration of the training and the curriculum to be followed have to be decided separately after each post-graduate course. In many cases, they may be exempted from taking such training.

CHAPTER XV

TRAINING FOR TECHNICAL MEN IN EMPLOYMENT

1. Opportunities should be given to everyone employed in some technical activity or the other, howsoever humble it may be, to rise to the highest position if the person has the necessary determination, capacity and perseverance.

2. For those in employment, the following are generally the ways offered for this purpose :

(a) Part-time or day-release courses with release from the factory for one or two days in a week in addition to Sunday.

(b) Sandwich courses.

(c) Evening courses.

(d) Correspondence courses.

All the four types of courses may be offered at all levels of technical education, starting from the craftsman's course to the doctorate course.

3. In the present stage of development of this country, day-release course may not be practical for persons employed in factories. The position can be reviewed five years hence when factories grow both in numbers and sizes and would have come into existence.

4. In this country, both the 'college-based' and the 'industry-based' types of sandwich, as in the U.K., should be encouraged. The Industrial Training Institutes should train students from the factories for the State Board Craftsman Certificate Examinations. The polytechnics should train students for the State Board Diploma Examination. Engineering colleges should start such sandwich courses to train duly qualified employees to sit for the Associate Membership Examination of professional institutions like the Institution of Engineers (India). Private enterprise should be encouraged by giving generous grants to start courses to train employees of factories according to a well-planned sandwich system for recognized certificate, diploma and professional examinations. These courses can be run all the months in a year in the above-mentioned institutions in cooperation with the neighbouring factories.

5. All efforts in the private sector should be encouraged to open professional institutes to train students through sandwich courses for varying types of conferments at craftsman, diploma and professional membership examination levels.

6. The present practice prevalent in many universities of recognizing institutes or colleges ill-equipped with teaching personnel, building and equipment should be severely discouraged. Instead, it is better to encourage persons working in factories to take sandwich courses. The equipment in the factory will make up to some extent deficiencies in equipment in a laboratory. The 'thickness of the sandwich', that is, the distribution of the time between academic and factory work, should be a matter of convenience to both the parties. The duration of the courses should be sufficient to pass the prescribed examinations.

7. The success of these courses will depend, to a considerable extent, on the size and nature of the firms who show interest in giving such training to their employees. During the period of work in the colleges, the employees may probably have to be paid just a stipend instead of their usual salaries.

8. It is very desirable to encourage evening classes at all levels. The Higher Secondary Technical Schools and the Industrial Training Institutes should make arrangements to hold evening classes in trades. The polytechnics can hold classes to coach students for National Diplomas, or diplomas awarded by the State Boards of Technical Education. The engineering colleges and a few well equipped polytechnics may also start evening classes for coaching students for the Associate Membership Examination of the Institution of Engineers (India). Private enterprise running colleges on its own can also start such evening classes as they do not involve any large outlay in workshop equipment and laboratories, for the reason that the students will already be in professional employment.

9. In India, hardly any attempt has been made to popularize correspondence courses in engineering. There are very few such courses. The Ministry of Education should insist on the various Regional Engineering Colleges to open correspondence courses in engineering both at degree and diploma level. The colleges should also coach students for professional examinations like the Associate Membership Examination of the Institution of Engineers (India). Such other colleges which are willing to take up this work should also be encouraged by generous grants. Such courses should be for a period of ten months at a stretch. At the end of every ten months, students should attend laboratory, workshop and drawing classes, and lectures for 60 days in a year. Retired teachers and retired professional engineers can be very usefully associated with this scheme.

CHAPTER XVI

TECHNICAL EDUCATION FOR WOMEN

1. There is here a considerable reserve of unused ability, which must be mobilized. Courses should be organized in existing institutions during the hours most suitable specially for married women, and wide publicity given to them.

CHAPTER XVII

TECHNICAL EDUCATION—EXTENSION WORK TO IMPART KNOWLEDGE OF LATEST DEVELOPMENTS TO PERSONNEL IN EMPLOYMENT

1. As the pace of discovery quickens, it will become increasingly important for practitioners in many fields to take courses at intervals to bring them up to date in their subjects. A wide variety of courses should be offered at all levels.

2. *At the craftsman level*, the Higher Secondary Technical Schools (now called Industrial Training Institutes or Junior Technical Schools) should be the centres where short courses should be held to teach operation of new types of machines and tools. Recent advances in the technology of trades like carpentry, welding, use of modern materials in building industry, etc. should also be taught in short courses. The duration of these courses need not exceed four weeks at a time; normally, they can be of two weeks.

3. *At post-diploma level*, the polytechnics should be the centres for organising short-term refresher courses. As in the case of craftsmen, refresher courses should be confined to very narrow fields of technology like tools used in a fitter's shop or a carpenter's shop, modern methods of lighting a factory building, building a radio set, precasting of reinforced and prestressed concrete beams, etc. In addition, courses may be organized on subjects pertaining to a foreman's work like increasing productivity amongst workmen, ensuring better safety in the factories, or better control in the use of materials used in manufacture, etc. The duration of these refresher courses should not exceed four weeks a time; normally, two weeks should be sufficient.

4. There are no technical journals published to cater primarily for the needs of the diploma holders. The Government at the Centre, should subsidize, at least in the early stages, the publication of a journal in the State languages and in English and Hindi.

5. In addition to publication of journals, every encouragement should be given for holding seminars. The duration of seminars may be of seven days and they may be organized in groups.

6. Diploma holders should also be encouraged to join the Institution of Engineers (India) in the grade of Students. The admission fees and the annual subscriptions for a number of bright boys may be paid by the Central and State Governments.

7. The Central and the State Governments should finance the Local Centres of the Institution of Engineers (India) for the purchase of books for their libraries which will be of value particularly to diploma holders.

8. *At the post-first degree level*, the engineering colleges, the Higher Institutes of Technology, and professional bodies like the Institution of Engineers (India) can all be centres of activity for imparting knowledge of the latest developments and techniques in science and technology to those in employment. The methods described hereinafter may be adopted.

9. *Refresher courses* can be of two types. In one type, the course will pertain to the learning of a new method or the latest method of design or of technique in the manufacture, erection or operation of a particular product or equipment or structure. The courses should be strictly limited to a very narrow field of speciality. In the second type, the refresher course is meant to make a survey of the developments in a particular technology during the last ten years or such other period.

10. *Symposia* may be held selecting particular subjects of study. Papers are invited and a discussion takes place on the subject. For example, 'Technical Education' can form a subject for a sympoaium.

11. *Seminars* can be held in the same manner as for post-diploma students.

12. *Joining professional institutions* like the Institution of Engineers (India) will enable them to use the libraries in the Local Centres of the Institution, attend technical lectures, and also obtain its technical journals. They can also come in contact with other co-workers in their field and learn by mutual discussions.

13. *At post-doctoral level*, the Higher Institutes of Technology and professional institutions like the Institution of Engineers (India) should be entrusted with the responsibility of conducting similar courses as refresher courses, seminars and symposia. In these, the scope of the subjects are narrowed down even more than at the post-first degree level. These should be held on an 'invitation basis', and should be open only to those invited to attend them. Experts from abroad should also be invited where necessary.

14. *Deputations abroad :* Another useful method is to depute persons both in and outside India. The depuation abroad may be for the following purposes :

(*a*) *At post-craftsmen level and post-diploma level :* Crafts teachers, foremen in factories and others (*i*) to actually work in factories or in institutes where their trade is being practised; (*ii*) to visit trade fairs, international exhibitions and firms; and (*iii*) to visit apprentice schools or trade schools where their trades are being taught.

(*b*) *At post-first degree level :* These should be deputed to visit actual works or factories under erection or in operation. Special efforts thould be made to send industrialist engineers abroad. One of the essential conditions should be that they should be actually engaged as proprietors of an industry by themselves, or should have worked in a small-scale industry for a minimum period of three years before they are sent abroad. They should be sent in large numbers to visit international fairs, exhibitions, and factories manufacturing similar products.

(*c*) *At post-doctoral level:* Teachers, design engineers employed in design offices either in public or private sectors, and research workers should be encouraged to write papers for international conferences or publish them in journals of repute in India. They should be encouraged to attend international conferences only if they fulfil both these conditions, first, they should have continually kept contact with technical developments by being members of a professional society in India, and second, their papers should have been accepted by the conference which they are attending.

The duration of these deputations at all levels should not exceed three months at a time.

15. *Deputations within the country:* Teachers, design engineers and research workers should be sent to work under actual factory or field conditions occasionally. Those working in factories should work in research and teaching institutions for short periods. The minimum period should be at least six months.

16. For the success of these schemes, four conditions are essential. They are: (*a*) financial support from Central and State Governments for organising refresher courses, seminars, strengthening the libraries in professional institutions at their Local Centres, and starting technical journals for technicians and craftsmen; (*b*) financial support both from Central and State Governments and industries to depute qualified persons to attend international fairs, exhibitions, conferences and even factories and projects; (*c*) cooperation from the employers both in the private and public sectors in releasing their personnel to attend these; and (*d*) creating awareness amongst technical personnel at all levels, specially at the post-craftsmán and post-diploma levels, of the opportunities that exist to improve their knowledge and efficiency. This should be done by all well known methods of publicity.

17. *Study of advanced technology abroad:* There are any number of areas of knowledge in which this country is lagging behind. In the years to come, with the the present rate of advance in knowledge, these areas will increase both in width and depth. Only an expert body which can keep continually in touch with the progress going on all over the world will able to demarcate these areas of study. Such a body should not consist only of eminent experts. The National Institute of Sciences, for example, by its very constitution works in complete isolation from industry, as its membership is confined only to the very best men in the sciences. It is not therefore reasonable to expect such a body to mark out areas of research which are of immediate need for the industrial development of the country.

The Institution of Engineers (India) has a more broad-based constitution and has expert engineers, scientists as well as industrialists and others in the country as its members. It is therefore better suited to be entrusted with the work of periodically marking out the areas of study for which persons have to be sent abroad, fixing the qualifications of the persons to be so deputed, the places and the duration of their studies, and other details. For the selection of such personnel, selection committees may be constituted consisting of an academic expert, a top industrialist engineer, and a representative of the Ministry of Education.

CHAPTER XVIII

TECHNICAL EDUCATION FOR THE PHYSICALLY HANDICAPPED

No recommendations.

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CHAPTER XIX

TECHNICAL EDUCATION AND MILITARY REQUIREMENTS

1. For obvious reasons, no attention was paid to development of technical education as an aid to strengthening defence till our country attained independence.

2. A considerable amount of expansion since 1951 has taken place in training personnel with technical education for military requirements. The number of schools and colleges for this purpose are still very few compared with the requirements of a vast country like ours.

3. In this country, full-fledged technological institutes of training, research and development should be established. Boys fresh from Higher Secondary Technical Schools or Higher Secondary Schools should be recruited. They should be given five-year integrated courses leading to a first degree in technology. The course should lead in the final year to a high degree of specialisation in narrow fields of technology (which are essential to defence requirements), that is, there should be an elective in the final year of the course.

4. Those who are fit should then be recruited as Lieutenants in the Army or to equivalent posts in the other services. After the necessary training, they should be posted back to the institutes to undergo post-graduate training for two years in a still narrower specially either in engineering or applied science.

5. These post-graduate courses should be of two types, one specialising in design for technical development, and another specialising in a narrow field in the basic sciences (physics or mathematics mostly) to fit them for research and development work of more sophisticated types. Those who successfully complete this training should be posted to field service for a year or two. They may again be reposted to the institutes to work either on the staff, or as a research fellow for a doctorate, or as a designer in the technical development section. In this way, the Defence Services will have technical men highly qualified in technology with experience in military service. These persons will be competent to hold positions of management and direction in military technical institutes.

6. The present technical colleges at Kirkee, Bangalore, Hyderabad and other places should all be converted along with the Defence Science Laboratories to full-fledged Military Technological Institutes of teaching, research and development, each specialising in a narrow field of technology. For example, there are four military establishments at Bangalore, one connected with the Air Force, one with research and development in telecommunications, another in aircraft design, and the fourth in gas turbines. Each of them should be converted into a full-fledged institute of teaching, research and development at all levels starting from a five-year integrated course for a first degree in engineering or technology to the doctoral level. Thus, there should be four Military Technological Institutes in Bangalore.

7. The management of these higher institutes which will probably be more than 30 in number to begin with has to be vested in an Executive Board like the Railway Board consisting of experts well known for their knowledge of science and/or technology

Each Board member should be a full-time worker engaged all the time in looking after the work of the institutes in his charge, and initiating new areas of research or technical development projects. The head of this Board should be invariably a military man, so that there is complete liaison between the defence work in the field and in the laboratories.

8. It is desirable to associate civilian scientists and engineers at all levels in these higher Military Technological Institutes. A few of them can also be members of the Executive Board.

CHAPTER XX

TRAINING FOR CITIZENSHIP—COORDINATION BETWEEN TECHNICAL EDUCATION, GENERAL EDUCATION, SCIENCE EDUCATION AND PHYSICAL CULTURE

1. As discussed in Chapter IV, the end and aim of all education is to develop such an integrated personality in the student that at the end of his education he is in a position to take his place as a responsible citizen of the country. His mind should be so trained that it is kept active and free from tensions, so that he can continually enjoy both the hours of his professional work and the hours of his leisure. His body should be kept active and as healthy as the mind. He should grow up in a disciplined manner, which means that in his professional work he can wholeheartedly cooperate in executing the wishes of his superior. He should also have developed the necessary personality and will power to get his orders obeyed cheerfully by his assistant.

CHAPTER XXI

ADMINISTRATION OF TECHNICAL EDUCATION

1. Development of technical education cannot thrive in isolation. It has to be coordinated with general education on one side, and with technical development on the other side. Good coordination exists in all the States between general education and technical education. The Departments of Education in each State are in a position to make a unified survey of educational problems in all their aspects according to their requirements from time to time. They have a unified control over the entire system of education ensuring proper interconnections between different levels and types of education. This system has worked well. There is no reason why this set-up should be disturbed. There is thus a strong case why education should continue to be State subject under the Constitution.

2. But for various reasons, mostly of finance, and dearth of proper talent, the States have not made much headway either in (a) fostering research, or (b) linking technical education with technical development in the country., It is in these fields of activity that the Centre can play its part effectively and usefully.

3. The States are mostly engaged in developing technical education at the graduate and under-graduate levels. It is necessary that there should be some sort of regulation and not regimentation in the activities connected with technical education. A high level policy-making statutory or advisory body is necessary. It has to guide

collection of data with regard to technical manpower requirements of all categories and also to get the progress in all aspects of technical education periodically evaluated. The present All-India Council of Technical Education with its regional organisations is doing excellent work. All that is necessary is to widen its scope of work.

4. The Directors of Technical Education, the Directors of Employment and Vocational Training, and the universities look after, between them, technical education at all levels. As a result of the changes suggested here, the Industrial Training Institutes under the control of the Labour Department will have to be transferred to the Directorate of Technical Education. These will be called Higher Technical Secondary Schools. In addition, hundreds of them will have to be started all over the country.

5. The entire system of apprentice training may continue to remain with the Labour Department. They may also start apprentice schools for giving General education full-time or in the evenings, to train students for Craftsman Certificate (Junior and Senior grade) examinations held on an all-India basis. They may continue to employ craft inspectors to supervise apprentice training not only in the bigger factories but also in small establishments, specially in the villages.

6. The other two functions of technical education, those of furthering research and linking technical education and technical development, are activities which should be the sole responsibility of the Centre. The States do not have the finances nor can they recruit personnel for this type of work. There will have to be movement of technical personnel from one institution to another, which will not be possible if the personnel are under State service. A high degree of coordination of activities is required at national level at every stage.

7. Regarding promotion of research by running of all types of courses at post-graduate levels, these should be done at the Higher Institutes of Technology (I.I.T.s.), the Regional Engineering Colleges, and other institutes which can do this type of work. Many new ones also have to be started. At least 75 per cent of the boys in these institutions should be engaged either in research or development and design courses. They should also be centres for running correspondence courses, holding external examinations at graduate and post-graduate levels, and where necessary, evening classes for training those in employment to appear for professional examinations. They should also be consultancy centres where industrialists can approach the professors for technical advice. Their services should also be made available freely for preparation of projects by industrialists anxious to improve or expand or start new industries.

8. In addition, the present Higher Institutes of Technology and the Regional Engineering Colleges should be remodelled so that they work more or less like a university campus with a number of institutes (which may be called departments) in it. Each should specialize in a narrow field of speciality with its own director, or chief professor.

9. The overall control of all these institutions and colleges which will entirely financed by the Centre, has to be under a full-time Technical Education Commission with a Chairman and two members. One of the members, the Administrative Member, will look after all financial matters, coordination in the purchase of equipment, recruiting of personnel, and such other matters of an administrative nature. The

second member, the Technical Member, will wholly devote himself to technical work to ensure maintenance of standards in examinations, suggest new courses to be opened, new areas for research, and all such other purely technical matters. He may have a small advisory body of experts to assist him, in which the Director-General of the Council of Scientific and Industrial Research and the Advisor, Defence Services can also be members. The Chairman, who should preferably be the Minister himself, should coordinate the activities of research and development not only in all technical institutes under the Centre, but also initiate, develop and coordinate research, development and design activities in the various universities and colleges under the control of the States. A policy similar to the University Grants Commission to foster areas of activity in one or two specialities at each of the engineering colleges and technical institutions at degree level in the States should be adopted. All the finances and the personnel connected with these activities should be completely under the Centre except for day-to-day control by the States.

The Chairman should also coordinate the activities of the Council of Scientific and Industrial Research with the activities in the technical institution. He should also associate himself with the activities of the Ministry of Industries and Commerce, the Ministry of Irrigation and Power, and such other Ministries who import equipment and raw materials in large quantities. It will be one of his important functions to initiate work of research, design and development of articles imported from abroad. He should also initiate work for substitution of scarce and costly raw materials imported from abroad.

10. The Minister, or any other person who is to work as Chairman where necessary, should be thoroughly conversant with all aspects of technical education from the highest to the lowest levels. He should have the personality, drive and tact to get things done quickly and efficiently.

11. In regard to internal management of higher technical institutes, both the present I.I.T.s, the Regional Engineering Colleges, and other similar institutes proposed to be managed entirely by the Centre have to work as fully autonomous institutes in their internal administration if the best results have to be had from them.

12. The present set-up of a Council, a Senate and Faculties is working well in most institutes. These should be retained. The Council should be the executive governing body that actively controls finance and external relations. It should have representatives of the Technical Education Commission, the Ministry of Finance, professional institutions like the Institution of Engineers (India), the National Institute of Sciences, industries, the Defence Science Organization, the University Grants Commission, Parliament, the Government of the State where the institute is situated, the universities in the region, the Senate, and the Faculties. In addition, a few distinguished persons well known for their learning and/or administrative experience in the management of technical education should also be nominated. The Chairman of the Council should be a member of the proposed Technical Education Commission.

13. The Council will no doubt consist predominantly of 'laymen' not experienced in teaching or actually doing research. This has been proposed because 'where men and women of wide experience and high standing in the world of affairs can spare time to

associate themselves with university (in this case institute) activities, the universities gain from the partnership strength and sagacity in their dealings with the outside world'.

14. It is better to have the Chairman from the Technical Education Commission so that coordination in the activities and uniformity in policies of administration are ensured at all the institutes and colleges.

15. The Senate is the apex of all academic activities. It should be composed entirely of academic members, all Professors and a few Senior Assistant Professors, one or two from each Faculty, the Librarian, the Registrar, and a Senior Accounts Officer of the institute. These should zealously guard the academic freedom mentioned earlier in this chapter.

16. The prestige of an institute depends entirely on the responsibility, integrity and zealousness shown in the maintenance of standards and the academic freedom of the Professors. The Council should remember that the achievement of high integrity and standards requires freedom and the opportunity to exercise responsibility.

17. The Senate should be supreme in all academic matters. It should constitute its own committees of experts for recommendation for the appointment and promotion of all staff members below the rank of Professors to the Council.

18. The faculties consisting of both junior and senior staff have an important role in preserving academic freedom. They should be able to advise the requirements of the courses. They should be permitted to experiment with methods and contents of courses, and appoint external examiners for periodical assessment of work and maintenance of standards in the departments. They should also advise on entrance requirements, lengths of courses, etc. The decisions of the Faculties, though advisory, should carry great weight with the Senate in its ultimate decisions.

CHAPTER XXII

LANGUAGE AND TECHNICAL EDUCATION

1. It is well recognized that a child can understand best when it is taught in its own mother tongue. If technical subjects can be taught in a regional language which happens to be the mother tongue of the majority of persons living in that region, there is another advantage. The children will spread technical ideas in their homes so that their parents and others in close contact with them will learn many things technical which may improve the efficiency of the tasks in which they may be engaged. These children serve incidentally as extension workers of technical education. The vocabulary of the language also grows richer by the addition of technical words.

2. An immediate necessity is therefore to make a beginning by imparting technical education in the regional languages from the elementary levels right up to the first degree course in engineering.

3. Before this is attempted, a beginning should be made immediately by encouraging authors to write text-books in technical subjects suitable at all levels up to the degree level.

4. The technical terminology in all the languages to be used in writing the text-books should be settled. It is better to keep as many technical terms as possible common in all the languages so that it will be easy for a person from one region to understand the language of another from a second region.

5. At the degree level, English will have to continue to be the medium of instruction for a long time to come. There can be no two opinions that we should eventually replace English by Hindi as a link language. By sticking to English, we have unconsciously become slavish admirers of everything British. We have lost the capacity to make an objective assessment of the technical knowledge available in other countries like Germany, France, Russia, Japan and others.

6. We have become such prisoners of our mind that we cannot even think of encouraging Indian authors to write text-books taking the best from all countries of the world. We have deliberately gone out of the way to kill Indian authorship by encouraging foreign firms to sell their books even below the cost of production of similar Indian books.

7. If it is considered that some books in the English language are excellent ones, the sensible way is to purchase a dozen or more copies of them for each of the technical Institutions in the country to be stocked in their libraries for the use of students. Similarly, books in German and other language should be got translated and copies of them stocked in the libraries of the technical institutions.

8. The only way of getting out of the shackles which are binding us now is to boldly break away from them and make a start in thinking, writing and talking in our own regional language about all subjects however abstruse they may be. In addition to the regional language, Hindi should also be freely used as it is to serve as the link language for all of us.

9. Before we start using the regional languages and Hindi, we should concentrate on speeding up the activities of the present translation bureaus.

10. A few regional language and text-book institutes should be started to bringing out text-books and for translating foreign books into the regional languages and Hindi.

11. Private firms should also be encouraged to produce text-books which should be got edited and approved by these institutes before prescribing them.

12. Recommendations have already been made that a start should also be made to publish a popular technical journal in English with its translation in all the other languages for the craftsman and diploma levels. This will help considerably in paving the way for writing text-books and eventually teaching courses in the regional languages.

13. Both in the U.K. and the U.S.S.R., and in many other countries also, it is compulsory to study one foreign language either at the secondary school or at the first degree college level. In this country also, the same system is in vogue. The study of the foreign language English begins even at the fifth standard, that is, at the elementary school stage. This should continue to be so, as more than 50 per cent of world's knowledge is in this language.

14. The system as it now prevails is such that the boys even after leaving the secondary school have a working knowledge of the English language. With a little more effort, by studying for a year or two beyond the secondary school stage, they are in a position to understand fairly well any book in English. This system should continue as long as the English language dominates in its importance over the others.

15. In addition, Hindi has to be learnt as a link language.

16. A student at the graduate level will have command over at least three languages, the regional language, Hindi and English. It is not desirable he should be loaded with the study of a fourth language.

17. A study of a fourth modern language should be limited to only those who wish to do research work. This is absolutely necessary for research workers so that they know of the latest developments in countries other than the English language countries, in their own field of speciality. It should be compulsory for all research workers to study a fourth modern language, German, Russian, French, or Japanese.

18. Much more important than making a study of a modern foreign language compulsory for research workers is the opening of schools for teaching only modern languages. Like the Robbins Committee, it is recommended that in all post-graduate technical institutes under the control of the Centre, a department of foreign languages should be established.

19. The following recommendation of the Robbins Committee is pertinent to this discussion : 'A course involving the study of two or three modern languages, with the emphasis on standards in oral fluency, translation and interpretation, and combined with the study of the relevant background of the countries concerned, will attract students and would offer them opportunities to develop at a high level their ability to use the languages in fields where skill in a language needs especially to be supported by knowledge of the background in which the skill is applied'. These are required in great numbers for translation work, for promoting export of goods from the country, and for a variety of other purposes.

CHAPTER XXIII

TEACHING METHODS—EXAMINATIONS—TEXT-BOOKS AND LIBRARIES

1. As in this country, in the earlier stages, the U.S.S.R. faced the same problem of reorienting their education system as we are doing now. It has been noted '*the school is now faced with the responsible task of uniquely re-educating the pupils psychology. Up to the present time, the school only prepared them for the institutions of higher education. Now when a considerable portion of those finishing school will go directly into life, our task is to nurture young people right from the beginning in the habits of work, in the love of work and in respect for labouring people*'. If teaching is done in all subjects with this change in outlook in the thousands of Higher Secondary Technical Schools to be started or now working, the majority of these ordinary workers in the factories will work with a productivity raised double, or may be many times more than now. Indian industry

will without doubt be lifted to a height beyond the reach of the industries of other countries.

2. In the U.S.S.R., schools are worked on a two-shift basis. We have to adopt the same system in view of the severe shortage of school buildings, and to meet the enormous demand for skilled craftsmen.

3. The syllabus in the U.S.S.R. for these technical schools consists of two parts. The first, called explanatory notes, includes a number of detailed directions on how certain topics should be presented, for example, 'in mathematics, in the tenth grade, in studying the volume of pyramids, the teacher may elect one of the two methods of presenting the topic described in the geometry text-books by A. P. Kiselev and by N. A. Glagolev'. The second part, the syllabus proper, lists in detail the topics to be covered, indicates the number of class hours in which each group of topics has to be covered, and the number of hours required by the students for home work.

4. The All-India Council of Technical Education should appoint appropriate panels drawn from the teaching staff of polytechnics, higher secondary schools, and others to write the syllabi for the various subjects. The syllabi should thoroughly cover the subject and drawn up in the same manner as in the U.S.S.R. Instructions to teachers in assigning practical and home work to students and in methods to be adopted for teaching the various topics in the subjects should also be drawn up in great detail for their general guidance.

5. The language and text-book institutes recommended to be established at a few regional centres should take up the work of producing the text-books.

6. There is general agreement that our methods of conducting examinations are very defective. The U.S.S.R. method is also open to many objections. It is firstly time-consuming. It leads to excessive cramming and is not test whether a boy has really understood the subject and whether his thinking faculty has improved as a result of the course he has undergone. It is difficult to maintain uniform standards if there is oral examination at all the places simultaneously.

7. The following system which is a combination of both the U.S.S.R. and our methods may be tried in a few places as an experimental measure. For each region, there should be a Controller of Examinations whose duty it is to conduct examinations and declare results. With the help of appropriate boards, he appoints question paper-setters in each subject. The question paper-setter sets twenty or more questions covering the entire subject. These questions are divided into six or more groups A, B, C, D, E, F, and so on. The number of groups should equal the number of questions the candidate has to answer in the time allotted to him. Each group will contain two or three questions *taken from the entire syllabus.* The Controller of Examinations draws lots, and fixes well in advance of the examination the number of the question in each group which has to be answered by a particular roll number, *e.g.*, roll number 10568 may have to answer question 1 in group A, question 3 in group B, question 1 in group C, and so on. This arrangement will apply to each of the question papers to be answered by the candidate, without it being necessary for the Controller of Examinations to draw lots for each question-paper separately. If he cannot answer any question in a

particular group, the candidate can choose any other question in the same group, but the question will be corrected for maximum of half the marks allotted to the question in the group. All answers should be written ones generally. There should be practical and oral examination in laboratory work and workshop practice.

8. The answer papers should be corrected mostly by the teachers themselves who are handling the classes. After the examination is over, all the paper-correctors will assemble in the same rooms where the candidates were sitting. Sealed packets of answer papers will be brought by the head of the institution, the seals broken open in the presence of the paper-correctors, and the papers got corrected. Those which remain uncorrected are sealed again and delivered the next day in the same manner as above. The answer books together with the marks sheets should be sent to the Controller of Examinations.

9. The Controller will declare results in two parts in each subject, the marks or grade the candidate has obtained in the first part which is based on the assignments, tests, etc. taken by the candidate in his school, and the grade or marks the candidate has obtained in part two which is based on his performance at the external examination. The advantage of this system is that no boy can hope to pass an examination by studying only half or a part of the prescribed syllabus. Since the choice of questions he has to answer is made at random, he has to prepare himself to answer questions from all portions of the syllabus.

10. Instead of our marking system, the grading system adopted in American schools, now adopted by a few of the Indian universities, is more rational and should be adopted in declaring results.

11. The year should be divided into two terms, each of six months duration. One month's holiday in each of the terms may be given.

12. Each term should be an unit in itself so that fresh admissions are made once every half-year, instead of yearly as now being done. This will prevent wastage of time by students passing in the September examinations. The students are also kept continually alert, as they have to face examinations every half-year. They can study better as the portions to be answered in a half-year is less than in a full year. Since the declaration of results is in two parts for each subject, the boys have to be continually alert, as failure in any part will entail repetition of the course in the subject. This system will prevent or at least lesson student indiscipline in schools as the boys have to work all the time during the year.

13. After the results are declared, the Controller should get a percentage of the answer papers revalued every year by different sets of examiners. Those guilty of misconduct or inefficiency should be removed, and their place may be taken by other teachers in the same school or in the neighbouring schools.

14. *At the diploma and first degree levels*, the writing of syllabi and text-books, the methods of teaching, and the method of holding examinations every six months and declaration of results in two parts, may follow the same pattern. In addition to written examinations, there should be more of oral and practical examinations in each

subject. Instead of the Controller, a Chairman of Board of Examiners should be appointed for each region or university.

15. *At the post-graduate degree and doctorate levels*, each institution should have full powers to frame its own syllabi.

16. A certain number of the staff members should be given leave and other adequate facilities to write text-books every year. No staff member should be given leave just to edit or revise a text-book. Authors should be adequately paid for doing this work.

17. Methods of teaching to be adopted and the number of hours for each topic, etc. in each subject should be settled at the beginning of each year at a meeting of all the teachers of a particular Faculty.

18. At the higher institutes which run post-graduate courses, there should be one or more Faculties for practically every subject like Civil Engineering, Mechanical Engineering, Physics, Mathematics, etc.

19. Each institute may be allowed to develop its own method of holding oral, written, and practical examinations and the method of defending the thesis.

20. At all oral examinations including that at the time of defending the thesis, at least two outside examiners should be associated, one an acknowledged expert in the field to be appointed by the Senate, and another who has rich professional experience outside the academic field. He can be a nominee of a professional institution like the Institution of Engineers (India). It should always be open to these outside examiners to call for answers of written examinations and review them. The Chairman of the Faculty will be the final authority in all matters concerning his Faculty. The Senate on getting reports from the Chairmen of the Faculty or Faculties in the several courses offered by a candidate will consolidate the mand declare results, using the same grading system. It is unnecessary to declare results in two parts.

21. Libraries should be under qualified librarians. There should be ample space for boys to study in the library premises, and the libraries should be kept open for adequate periods for the use of the students.

CHAPTER XXIV

FINANCE AND EQUIPMENT PLANNING FOR TECHNICAL INSTITUTIONS

1. Nearly 50 to 60 per cent of the capital cost of an engineering college is normally earmarked for the purchase of equipment. The suggested criterion for planning the outlay of about Rs. 50-60 crores likely to be spent on equipment in the next ten years are : (a) to plan the equipment specification in relation to the anticipated needs arising out of modernization and diversification of courses ; (b) to plan the design and manufacture of the required equipment in our country to the maximum extent possible ; and (c) to plan the procedure for purchase to cut down the time of obtaining the equipment as quickly as possible.

2. The functions of a laboratory should be (a) to impart training in the operation and testing of machines, instruments and other equipment; (b) to impart training for verification of theoretical principles and concepts; and (c) to impart training in the design and fabrication of equipment for new processes and testing new concepts and theories.

3. The Technical Education Commission should establish a cell for supply of equipment. A fresh list of equipment required in the colleges, polytechnics, and Higher Secondary Technical Schools should be got prepared. The Technical Member of the Commission should allocate the work of designing all the equipment required amongst the technical institutions in the country as design projects. The designers should be paid generously for this work, as well as those who assist them. These designs should be supplied freely to all manufacturers and technical institutions to make or get them made anywhere in the country. The foreign exchange necessary for purchasing some of the parts of the equipment should be freely given. Those who supervise the fabrication of the equipment by frequent inspections, testing, and otherwise help in its fabrication should also be paid. Purchase of equipment which cannot be manufactured here and require hundred per cent foreign exchange should also be allowed in deserving cases.

4. The present difficulties in getting equipment has been described in great detail in the paper which forms this chapter. These should be corrected immediately.

CHAPTER XXV

TEACHERS' WELFARE AND THEIR RECRUITMENT

1. The method of recruitment followed now is meeting satisfactorily the requirements of teaching staff up to the first degree level of technical education.

2. Part-time teaching staff make an indispensable contribution to the work of technical institutions, coming as they do from all walks of life, and particularly welcome are those with wide experience and holding positions of responsibility in industry and commerce.

3. Most teachers achieve proficiency only after years of practice. It is better that every teacher, whatever may be the level, from the lowest level to the post-graduate level, has a period of instruction in teaching techniques before he takes up his duties. These teacher training courses may be offered as a full-time course in special Technical Teacher Training Colleges. This training is very essential for those who have to take up their duties as teachers in Higher Secondary Technical Schools and polytechnics.

4. There should be free interchange of teachers in schools with those of foreign countries wherever this is feasible.

5. Every teacher should be entitled to sabbatical leave to go abroad for study and research. This should be encouraged specially amongst teachers handling graduate and post-graduate classes.

6. Directly related to the quality of teaching is the encouragement offered to teachers to keep themselves abreast with the latest technical developments in their subjects and in the theory and practice of teaching their subjects in technical institutions. This is best achieved by insisting that every teacher should join a professional institution like the Institution of Engineers (India) either as an Affiliate Member if he is a diploma holder or as a Corporate Member if he is a graduate. He can have access to all the latest literature available in his field of speciality as well as in technical education, as the Institution of Engineers deal with all aspects of engineering and technology including teaching. His contact with professional engineers in industry will greatly help him to orient his teaching or research to the requirements of industry so that his students do not find themselves misfits when they enter industry.

7. Every teacher should be given a small allowance each year to cover the cost of joining such institutions, and purchasing a few technical books and other accessories for his personal use.

8. All teachers who papers are accepted for publication should be deputed to attend the meetings where their papers are discussed. Others who can usefully contribute to technical discussions should also be deputed.

9. The Central Government should finance this expenditure, as well as that of deputing teachers abroad for higher studies or for research work in particular fields. They should also finance teachers by meeting their salary and necessary expenditure during the period they are deputed to write text-books. The teachers should not be asked to surrender to the Government any portion of the royalties obtained from writing and sale of the text-books. These should be done in the larger interests of the country as a whole, as investment in increasing the efficiency of a teacher results in increasing the efficiency of his students who in their turn increase technical development and national wealth.

10. The number of hours a teacher has to spend in lecturing, tutorials, correcting home assignments, organizing group discussions and lectures amongst students, doing research work, and administrative work has to be apportioned. In research work again, the time he is to spend on giving technical consultations to industry, the time he is to spend on designing and fabricating equipment of new types, and the time he is to spend in guiding students for obtaining research conferments like M.Sc. and Ph.D., have to be determined. There can be no hard and fast rules about these, as the apportionment of work depends on a close and intimate knowledge of the capacity of each staff member.

11. It is absurd to think that any one of the various types of work mentioned above is superior to another. All are essential for development of technical education. The head of each Faculty or department in post-graduate institutions and colleges for training students for the first degree should be the sole judge for allocating work amongst the members of his staff, subject to the overall approval of the Senate or the College Council, or by whatever name the academic body is called.

12. The Government, and the governing bodies or advisory bodies of the institutions or colleges, are at present entirely guided by the Director or the Head. Directors

sometimes bring their own prejudices to bear on subjects concerning the recruitment and future of the teaching staff. Most professors are indifferent to problems concerning the development of their institutions owing to a feeling of frustration that their words hardly carry any weight. It is therefore necessary that the Senate or the College Council should be the sole authority in all academic matters in autonomous institutions.

13. The head of an institution may be appointed for a period of five years at a time. The appointment may go round by turns amongst the heads of departments, or the head of the institution may be given extensions in periods of five years at a time. No hard and fast rule can be laid down for the procedure to be followed. The procedure to be followed is a matter which should be left entirely to the Governing Council or the Syndicate of the university. The recommendation can be made that the heads of institutions may be appointed for periods of five years at a time, so that the other heads of departments may also have a chance of their being considered for promotion.

14. During the time the head of a department is also the head of the institution, he may be given a higher grade, which he should not lose if he reverts back to his own post at the end of his term. Many heads of institutions would like to do so of their own free will, if they find professorial work is more interesting than administrative work, and also if their emoluments do not suffer any reduction by such reversion. This procedure will bring a democratic atmosphere in the institution, creating a climate in which academic achievements can grow congenially.

15. The present proportion of teachers to students at all levels of technical education is thoroughly inadequate. This requires to be corrected. In the U.S.S.R., it is 10.3 to 1 and in the U.S.A., it is 12 to 1. In this country also, a ratio of 10 to 1 may be taken as a guide for all institutions up to the degree level.

16. For the degree level, work load for each staff member should be the main criterion. The ratio of teacher to students will naturally vary with the number of electives the college is offering in its courses.

17. At the post-graduate level, work load should be the only criterion. The number of subjects taught and the tempo of research and development work going on in the institutes is a major factor for consideration. Another important factor is the amount of work done by the teaching staff in consultation work.

18. Every effort should be made to encourage such types of consultation work which will lead ultimately to problems of applied or basic research in the laboratory or in the field, or in taking out a patent for a process, or in the design of new types of equipment. Consultation work of a routine type mainly bringing in money to the staff is not a desirable activity. But consultation work which leads to widening or deepening of technical knowledge deserves every encouragement. Generous increases in staff should be allowed in all departments or faculties in post-graduate institutions where research or consultant work is being carried on vigorously, or even when there is scope for such activities being taken up. There should be nothing like a teacher-student ratio in institutes of higher learning.

19. The ratio between senior and junior position in technical institutions is a subject which requires careful consideration. In so far as the Higher Technical Secon-

dary Schools are concerned, the recruitment of staff should be the responsibility of the State Governments. The ratio of senior to junior positions has naturally to be fixed by the State Governments, taking into consideration the ratio between junior and senior posts sanctioned for the Higher Secondary Schools.

20. It should also be noted that technically qualified staff can only be recruited if they are offered at least the same emoluments corresponding to the positions they would get in the technical departments of the same Government or in industry in the public and private sectors.

21. So far as diploma and first degree courses are concerned, the position is different. It has to be largely functional. For the diploma course, the head of the polytechnic has to be of the grade of a Professor. The heads of various departments have to be of the grade of Assistant Professors and the rest of the lecturing staff have to be Lecturers. There may also be a few instructors to lecture, correct home assignments, and hold practical and laboratory classes.

22. In addition, all Lecturers who have put in 15 years of satisfactory service as Lecturers or in equivalent posts in industry or otherwise and have obtained at least a first degree in engineering, science, or its equivalent should be promoted as Assistant Professors on a personal basis.

23. Similarly, all those who have obtained a Master's degree and have put in 25 years of service on the aggregate as a Lecturer and an Assistant Professor, and in equivalent posts in industry or otherwise should be promoted as Professors.

24. Assistant Professors and Lecturers should be encouraged to study for M.E. degree courses in Industrialist Engineering. This will be extremely useful in giving them the necessary technical knowledge and the psychological orientation necessary for training students for industry.

25. In addition, all Lecturers should undergo training for a year in a Technical Teachers Training College.

26. Both Professors and Assistant Professors should be members of a professional institution.

27. At the first degree colleges also, the same principles can govern the allocation of senior and junior positions. In a college, there should be a Professor for each of the branches as previously suggested. In addition, there should also be promotions from Lecturers to Assistant Professors for all those who have satisfactorily completed 10 years of service as a Lecturer and in equivalent jobs, provided they acquire a Master's degree in engineering and are members of a professional institution. Similarly, Assistant Professors with M.E. or M.Sc. qualifications should be promoted as Professors if they have on the aggregate (in the same manner mentioned above) put in satisfactory service of 25 years. For those who have a doctorate, a reduction of five years and 10 years may be shown for promotional posts of Assistant Professors and Professors.

28. For those conducting post-graduate courses, different rules have to be applied. Every department in each faculty of a post-graduate course should have at least one Professor. As already recommended, what is now considered as a branch of engineering

like Civil Engineering, will hereafter be called the Faculty of Civil Engineering in a post-graduate institution. Every head of a laboratory or those guiding not more than five students in the dissertation courses, design and development, or research work should be an Assistant Professor, that is, there should normally be one Assistant Professor for a maximum of five post-graduate students. There should be a Lecturer for every speciality. There should also be promotional vacancies which should be filled up in the same manner as indicated in the previous paragraphs.

29. There should be a system of out-of-turn promotions in recognition of exceptionally good work.

30. Regarding service, the age of retirement in all cases where there is heavy lecturing work should be 60 years normally. Further extensions year by year may be given in deserving cases.

31. In case of teachers, whose work is more in the nature of guiding research, design and development projects, and consultative work with industry and administration, and as such does not involve much of actual lecturing, the age of superannuation should be 65 years.

32. Professors doing post-graduate work should not be allowed to retire from professional activities, though they may cease to do administrative work after attaining 65 years of age. They should be allowed to work as long as they can on a suitable remuneration in the same or other institutions of their choice. This generosity shown to a few professors in the Country will go a long way in enhancing the prestige of the profession and attracting the best talents to this profession.

33. Regarding salaries, this is a matter which should be settled, taking into consideration, the salaries and prospects of the persons of the same qualifications and merit when they get into employment in the private and public sectors. These change from time to time and no hard and fast rule can be adopted.

34. Teachers should be given all social security benefits such as insurance, sickness, pension and gratuity benefits. They should have at least the same medical facilities as those under the Employees State Insurance Schemes.

35. Construction of quarters for teachers in most places should be taken up on a large scale. There is great difficulty for teachers to get quarters at reasonable rents.

36. There should be frequent interchange of places between teachers and executives in industry. These should be encouraged till the professorial level. Professors should not be allowed to work in industry dislocating their work in the college. After once they have become Professors, there is no question of leaving their faculty for long periods.

37. There should be a system of recruiting qualified persons from industry for part-time teaching or laboratory or practical work. Certain subjects can be handled better by men in the profession rather than by teachers wedded to a purely academic life.

38. There should also be a system of employing post-graduate students also both for teaching practicals and correction of test papers. This will also help post-graduate students to develop the art of expressing themselves in a methodical and lucid manner.

CHAPTER XXVI

STUDENTS' WELFARE, STUDENT ADMISSIONS AND DISCIPLINE

1. The opportunities afforded under the proposed scheme for all students to study right up to the highest level, the preference shown to students in the matter of admission from one lower course to a higher course, the pay and prospects of students completing the courses, the scholarships available, and a host of other information useful both to students and to their parents should be published widely.

2. Information on each in the form of a booklet may deal with a particular level of course offered, a particular aspect of technical education like variety and amount of scholarships available, variety of courses offered, opportunities for employment, and so on. These should be printed in all the regional languages and English and distributed freely to all elementary schools, high schools, and other places which are likely to attract the attention of students and their guardians.

This work should be entrusted to the language and text-books institutes proposed to be established at a few regional centres.

4. There should be no difficulty in the matter of selecting students to the Higher Secondary Technical Schools. Till people come to know that the technical school is the main feeder for higher technical education, a good number of scholarships have to be provided to induce students to join these schools.

5. Selection of students for diploma and first degree courses should be strictly on merit, based on the candidate's performance both in the class assignments and the final examinations. As marks for classwork are likely to be boosted, only those who have got above a certain minimum should be considered as eligible for admission to the technical courses both at the diploma and degree levels. From amongst the eligible, a further list strictly in order of merit based on the performance of the candidate in the public examinations should be made. There is no harm in making reservation of seats according to statutory requirements for those belonging to scheduled classes, hill tribes, children of defence personnel whose parents have died in action, and so on. Even in these, selection should be by merit amongst those belonging to each of these categories.

6. Where marks have to be considered from more than one Technical Board of Examinations or University, common entrance examinations may be held for each region, specially for admission to the polytechnics.

7. The present system of selection of students for the Indian Institutes of Technology is a good one. It should include all applicants to the Regional Engineering Colleges also, and such other colleges which would like to join the scheme. The system takes into account the previous academic records of the body as well as his performance at the entrance examination.

8. For admission to post-graduate institutions, the Senate of each institution should determine its own methods of selection.

9. The practice of students being given admission to private technical institutions on payment of 'donations' should be severely condemned, as it goes against the very

fundamental principle of education which is recognition of merit. Merit and merit alone should be the sole criterion for admission. Such private colleges, if they so desire, can charge enhanced fees.

10. Every year an Admission Board should be formed which will prepare lists of candidates eligible for admission strictly in order of merit, under the various categories, general and reservations (scheduled castes, etc.), under which admissions have to be made. It is only from this list that offers of admission should be made, following the one below rule, when anyone who has been offered admission fails to join the courses. Private colleges have also to pick out candidates from the same list, follow the same one below rule, when any candidate fails to join their institution.

11. Lecturing to the classes is one method of instruction to the students by the teacher. In addition, in practicals and workshops, the teacher comes in closer contact with the boys. In addition, each teacher should be assigned 20 to 30 students to his charge. It is his duty to meet them, individually at least once every two months, and talk to him about the progress of his studies, his difficulties regarding purchasing text-books, submitting assignments and maintaining regularity of attendance, and other matters of a personal nature. The effect of this will be that the student will feel a greater sense of security.

12. It is not all students who enter a course that get out of it after successfully passing the final examination. Some wastage is no doubt inevitable in any system of education. There will always be a certain number of students who discover that they have made a wrong choice, others who prove unable to develop intellectually much beyond the point they had reached on entry, and some who withdraw or fail because of ill-health or other personal reasons. Generally, the order of wastage in our country is as high as 40-50 percent at the degree levels. This is due partly to inadequate guidance by the teaching staff. Wastage can be reduced by appointing paid counsellors (teachers) to look after the students as mentioned in para 11 above.

13. It is most unfortunate that our system of examinations is such that the boys are always kept in great tension just at the time of the examinations. Most do hardly any work during the rest of the time. In order to spread out their work evenly throughout the year, marks should be assigned for home work. In order to obviate personal influences getting in the evaluation of home assignments, final results should be declared in two parts as already recommended.

14. Since examinations are to be held once every six months as in American universities and admissions also made once every six months, wastage will be reduced to a minimum. Students also have their work spread out better. The strain is eased, as they will be examined only in the portions covered in each term. Students should also be given the facility of passing subjectwise. No student can go to the class in the next higher term unless he passes in all the subjects studied in the previous term.

15. Hostels with single rooms are a necessity. The present programme of building such hostels requires acceleration. Hostels should have rooms for praying,

reading, holding debates, showing educational films, facilities for indoor games, music and acting, and all such activities which gives recreation to a student.

16. Suitable medical facilities should be provided for all students.

17. Sports, gymnasium and N.C.C. activities and Students' Union should be actively encouraged.

18. These are occasions when students come in contact with the older boys. In addition, there should be open college days when the college laboratories and museums can be thrown open to the public.

19. Some of the colleges can give their own awards to their students who have distinguished themselves either in studies, sports, or other activities. Memberships of the college may be conferred on these boys, and certificates awarded at college convocations specially held for this purpose. Some of the teachers should also be given these membership awards. All these activities will foster pride in their colleges and brotherhood among their alumni.

20. Hobbies such as model making in technical institutes are a very important activity. Every technical institution including Higher Secondary Technical Schools should have museums attached to them where a few of the models made by the students should be exhibited.

21. Generous scholarships should be given both to the needy and the merited students. Even the scholarships given to needy students should be called poverty-*cum*-merit scholarships. Every student should be made to feel a sense of pride and self-confidence that he has earned a scholarship and not succeeded in begging for it.

22. Students should also be encouraged to earn wages by doing manual work in the college campus where necessary. Senior students may be paid wages for correcting home assignments and test papers of junior students.

23. Loan scholarships should be given to students coming from middle class families to complete their education. These should be payable after the student starts earning.

24. Cooperative societies in every technical institution including Higher Secondary Technical Schools for supply of books, instruments and other requirements of students should be formed.

CHAPTER XXVII

RESEARCH AND STATISTICAL ORGANIZATION FOR DEVELOPMENT OF TECHNICAL EDUCATION AT ALL LEVELS

1. There can be no progress without research. The very methodology of research requires (a) programming the result to be achieved, that is, fixing the object to be achieved by investigations ; (b) collection of data of what has been done both in and outside the country ; (c) detailed study of data to find out deficiencies and achievements ; (d) planning and conducting investigations ; (e) collection of data from these investigations ; (f) arriving at conclusions ; (g) generalizing them ; and (h) publicising them for general adoption.

2. A research and statistical organization which deals with all the main aspects of research in technical education at all levels is a vital necessity for both general and technical development of the country. This needs no argument, the need for such an organization. Its functions can be as under :

(a) It will collect information on all aspects of technical education and systems in vogue in various countries.

(b) It will collect data with regard to (i) output of technically qualified men at all levels ; (ii) technical manpower requirements at all levels, regionwise, and industrywise ; (iii) technical manpower requirements at all levels to start new industries or expand existing ones according to programmes of the Planning Commission ; (iv) increase in productivity as a result of giving regular training to craftsmen ; (v) increase in economic growth, and growth of science-based industries employing high level technical personnel such as the chemical, electricity, electronics, petroleum, automobile, machine tool and heavy electrical machinery industries, as a result of newer methods of technical education imparted to students ; (vi) requirements of technical personnel for and growth of industries manufacturing new products and new devices for automation of technical processes ; (vii) requirements of technical personnel for industrial research ; (viii) for export and reduction of imports of machines and spares ; and (ix) all other data necessary for linking technical education with technical development.

(c) It will periodically review what the purpose and aims of technical education should be.

(d) It will determine the levels at which technical education has to be imparted.

(e) It will investigate methods of coordination between technical education, science education and general education.

(f) It will investigate how to correlate increase in output of technical personnel at various levels with increase in industrial output, and in increase of the standards in living of the common man.

(g) It will investigate the effect of technical education or general standards of morality, integrity and behaviour, and other aspects concerned with the general well-being of society.

(h) It will investigate the place of languages in imparting technical education.

(i) It will investigate the various methods to be adopted for maintaining standards in technical education, for periodical revision of curricula, and for opening of new courses.

(j) It will investigate the various methods of imparting knowledge of the latest developments and techniques in science and technology to those in employment.

(k) It will investigate the best method of giving publicity of the facilities available for technical education.

(l) It will investigate how best to correlate the activities of technical institutions with the activities of the University Grants Commission, the Council of Scientific and Industrial Research, and other research bodies in the private and public sectors.

(m) It will investigate all problems pertaining to teachers' welfare, teaching methods, text-books, teaching aids, and reading materials.

(n) It will investigate all problems pertaining to students' welfare.

(o) It will investigate all problems pertaining to administration of technical institutions.

(p) All other matters which are directly or indirectly connected with technical education at all levels.

3. This organization should have a full time Director assisted by numerous advisory panels. He should work directly under the Technical Education Commission.

PART II—REPORT

CHAPTER I

INTRODUCTION—METHOD FOLLOWED IN WRITING THE REPORT

1.1 *General:* The Ministry of Education set up a Central Planning Group now called the *Education Commission* to prepare a broad outline of a perspective plan of educational development during the next 15 years (1966-1981), and against its background to prepare programmes for inclusion in the Fourth Five-Year Plan (1966-1971). The Institution of Engineers (India) having on its Roll over 40,000 Students getting trained as engineers and more than 13,000 engineering graduates including directors, chief executives, designers and planners in engineering concerns, directors, professors and other research workers and teachers in engineering laboratories and institutions, and others like administrators, industrial consultants and technical experts, is vitally interested in the development of technical education in the country. In order to provide a forum for discussion on all aspects of technical education, the Council of the Institution decided to hold a Seminar on this subject. The Seminar was held not only at the 45th Annual Convention of the Institution in Lucknow in February this year but also at many of the Local Centres of the Institution.

1.2 *Scheme for discussion of the subject:* Any scheme of planning for education has necessarily to take into consideration the history of the development of technical education and the social and economic conditions as exist in the country today. This is necessary as any scheme that is suggested should be such that it will cause minimum emotional disturbance in the minds of those who are to implement it—the administrators, the teachers and the students. It should not look revolutionary in concept though actually it may be so. Everyone concerned in its implementation should feel capable of doing so without much difficulty. The new generation of students, research workers and others should be able to get their training under the new scheme without frustration for want of the necessary qualified staff, equipment or buildings.

1.3 Another very important consideration in formulating a scheme should be that it should fit in with the declared objectives of the Government. These have been stated to be the achievement of a socialistic pattern of society, raising as quickly as possible the standard of living of the common man specially the large population living in the villages. The scheme of technical education should therefore have as one of its important objectives the training of persons to increase productivity and technical knowhow at all levels starting from the village craftsman to the highest level of an engineer-scientist.

1.4 Another objective is the elimination or at least considerable reduction in our dependence on foreign technical 'knowhow'. Expressing the same idea in a positive way, the scheme should be such that designing and fabricating new equipment or improving the efficiency of existing ones forms an integral part of technical education at all levels. Efficiency in formulating the scheme should be measured by the extent to which sophisticated equipment have been designed, fabricated and used in the villages and the cities, a few years after our scheme is implemented.

1.5 It is against this background that each topic under the subject of the Seminar is discussed under the following headings : (a) practice prevailing in other countries, and (b) practice recommended for adoption. The deficiencies in the present system of technical education have been discussed in the several papers indicated in the Appendix to Chapter III.

CHAPTER II

HISTORICAL BACKGROUND

2.1 'Engineering is the activity of man by which he seeks to control and direct the resources of nature to his own use and benefit. Taken on this broad basis, it constitutes one of the main endeavours of man and is quite distinct from his other activities such as his achievements in politics and government, in artistic expression or his religious aspirations, and his reaching out to the unknown. It traces its beginnings almost to the dawn of human existence on this planet and would embrace the craft of the prehistoric hunter and his primitive attempts to make and use weapons. It would cover the endeavours of man to master materials available from the Stone Age and Eotechnic Era onwards.

The ancients who come within recorded history have some very considerable engineering works to their credit. Many can still be seen in whole or in part, such as the pyramids of the Egyptians, the magnificent temples and public buildings of the Assyrians, of the Greeks and the Romans, the irrigation systems and aqueducts of the Egyptians and the Romans, and the remarkable roadways, still the basis of some of the English roads today after 2,000 years have passed.

Throughout this long period of development, science, which is the understanding of basic principles, played but a small part. Knowledge, largely gained from experience, was passed from generation to generation, mainly through a priestly caste, as a body of known and established fact.

It was not until the fall of Constantinople in 1453, and the revival of learning that followed it, that men's minds began to appreciate the importance of a knowledge of natural laws in supplementing the techniques and skill already developed.[1]

2.2 In India, from the Vedic times, if not earlier, technical training was imparted from father to son. It was also restricted in scope to certain castes. Each caste or community specialized generally in a particular craft. In recent years, 'the impulse for creation of centres of technical training came from the British rulers and it arose out of the necessity for the training of the overseers for construction and maintenance of public buildings, roads, canals and ports, and for the training of artisans and craftsmen for the use of instruments and apparatus needed for the army, the navy, and the survey department. The superintending engineers were mostly recruited from Britain from the Cooper's Hill College and this applied as well to foremen and artificers ; but this could not be done in the case of the lower grades—craftsmen, artisans and sub-overseers who were recruited locally. As they were mostly illiterate, efficiency was low. The necessity to make them more efficient by giving them elementary lessons in reading, writing, arithmetic, geometry, and mechanics, led to the establishment of industrial schools attached to ordnance factories and other engineering establishments. While it is stated that such schools existed in Calcutta and Bombay as early as 1825, the first authentic account we have is that of the industrial school established, at Guindy, Madras, in 1842, attached to the Gun Carriage Factory there. A school for the training of overseers was known to exist in Poona in 1854.[1] The first engineering College was established at Roorkee in the United Provinces in 1847 for training of civil engineers. In 1915, the Indian Institute of Science, Bangalore, opened courses in electrical engineering leading to the grant of certificates and associateships. The credit of first starting courses at degree level in mechanical, electrical and chemical engineering should go to the leaders of the Swadeshi movement in Bengal who in 1907 started a National Council of Education, the offspring of which is the present College of Engineering and Technology at Jadavpur. Thanks to the indefatigable efforts of the great patriot Pandit Madan Mohan Malaviya, degree courses in metallurgy were started in 1917 in the Benares Hindu University. Since then the development of technical education at all levels both in its diversity and numbers has been rapid and more so after the advent of independence in 1947.

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[1] 'Technical Education' by P.F.R Venables. *G. Bell and Sons, Ltd.*, 1956.

2.3 Before steps for further development of engineering education are discussed against this historical background, it is necessary to remember that *engineering is both a science and an art*. In the words of Lord Dudley Gordon,[2] 'Engineering is the great constructive profession, *which benefits the world by things made and done, and not merely talked about*. The great steps in its progress have been taken by exceptional men who, by drawing correct conclusions from insufficient premises, in other words, guessing wisely—and then daring to risk their reputations and their fortunes in putting their ideas to the test—have achieved results afterwards to be explained in detail by the theorists. They used, of course, all the scientific knowledge they possessed, much or little, but their unformulated wisdom known as intuition, and above all their enterprise in using it, was most frequently the cause of their success. *Deplorable as it may seem to the academic mind, it has to admitted that industrial practice has often run well ahead of theory.* Water wheels, for example, were in use centuries before there was any formal theory of hydraulics ; the steam engine was brought to a very high degree of perfection more than a generation before there was any science of thermodynamics ; steel was hardened for ages before metallurgists could give a proper explanation of it, and we should, indeed never, have had any science of metallurgy at all if steel and iron had not previously been made............'.

Engineering is both a science and an art in another sense. It is invariably linked with economics. An engineer should have a good knowledge of the extent of accuracy (call it perfection or quality of work to be done) to which a particular work has to be done. Insufficiency in the quality may lead to dangerous results—too much of it to excessive waste of money and delay and too little of it to inefficiency and structural insecurity. Engineering is an art when it comes to execution of engineering projects.

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[1] Report of the University Education Commission (Radhakrishnan Report), September 1948-August 1949, Vol. I.

[2] Presidential Address to the Institution of Mechanical Engineers, London, 1947.

Engineers rarely work in isolation. Almost always, projects are carried out by teams of engineers, which involve relationship with seniors, equals and subordinates. There are few professions where human relations play such a vital part in determining quality and speed in the execution of projects.

Appendix

Paper 1. 'Suggestions for Better Technical Education in India' by Dr. A. K. Chatterjee and Prof. B. S. Rao, para 2.

CHAPTER III

SOCIAL AND ECONOMIC BACKGROUND : DEFICENCES IN THE PRESENT SYSTEM

3.1 In December 1954,[1] the Parliament declared that the broad objective of economic policy should be to achieve a socalistic pattern of society. A socialistic pattern of society has to be based on increased production realized through the use of modern science and technology and on equitable distribution of income and wealth. The Planning Commission in their draft of the Third Five-Year Plan have stated that 'among the aspects of retarded development to which planning has to address itself are : (i) low levels of productivity ; (ii) income and living ; (iii) the high proportion of the population engaged in agriculture ; (iv) the existence of large scale unemployment and underemployment ; (v) the dependence on more advanced countries for equipment and technical knowledge ; and (vi) inadequate rate of economic growth'.

3.2 Regarding raising of low levels of productivity, it has to be done for the nation as a whole.[1] 'It is only then that the general level of wellbeing can be effectively raised. At the base of this entire effort are the various programmes of development for building up the country's human resources, specially education and health, and programmes for raising the levels of skills and technical and scientific knowledge and for scientific and technological research. With this in view, it is proposed to provide for free and compulsory education for the age group 6-11 years. Making allowance for slower progress in female education in certain backward areas, it is estimated that the proportion of pupils to the number of children will go up from 60 to 80 per cent in the age group 6-11, and from 20 to 30 per cent in the age group 14-17. The total number of students in schools will go up from 41 million in 1960-61 to 65 million in 1965-66'. Actually, the number of students in 1960-61 was 47.8 millions.[2]

3.3 Regarding income and living,[1] the population is expected to be 480 millions in 1966, 528 millions in 1971, and 568 millions in 1976. It is expected that in relation to 1948-49 prices, the doubling of national income from Rs. 9,530 crores to Rs. 19,060 crores might be achieved by 1967-68 and of per capita income from Rs. 249.6 to Rs. 499.2 in 1973-74. In 1961-62, on the basis of 1948-49 prices, national income was Rs. 13,020 crores and per capita income was Rs. 293.4.

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[1] 'Third Five-Year Plan—a Draft Outline.' 'Planning Commissions, Government of India, June 1960

[2] 'India 1963.' Publications Division, Government of India.

3.4 Another important objective[1] to be achieved by the end of the Fifth Plan is the reduction of the proportion of the population dependent on agriculture from the present level of about 69 to 70 per cent to about 60 per cent.

3.5 Regarding the existence of large scale under- and unemployment, the planning Commission[1] has stated that the Third Plan may start with a backlog of unemployment greater by about two millions than at the start of the Second Plan. It is estimated that new entrants to the labour force in the Third Plan period would be about 15 millions of whom about a third may be in the urban areas. Sample surveys have consistently indicated that the incidence of unemployment in urban areas is particularly high among young men who have completed secondary or junior college education. *The problems of such persons with incomplete education need special attention.* In the rural areas, there is little visible unemployment. There is of course widespread underemployment; persons engaged in agriculture and in associated occupations have productive work only during the appropriate season.

3.6 Regarding inadequate rate of economic growth, this has already been mentioned in para 3.3. What is however pertinent directly to framing of a plan for technical education is the rate of growth of industries, power production, transport and communications, housing programmes, and all other forms of activity which requires technical skill.

The index of industrial production rose from 100 in 1956 to 150 in 1962. It is increasing at the rate of 8 to 9 per cent per annum. The outlay under the Third Plan for furthering activities of a technical nature are as follows:

	Rs. crores
Power	975
Village and small industries	435
Industry and minerals	2,500
Transport and communication	1,650

In addition, the outlays to be incurred on employment of teachers for technical training, of workers for research in National Laboratories and other research institutions, and of technical personnel employed in developing and maintaining irrigation works, agriculture, community development and defence are quite considerable though not mentioned here.

3.7 The overall percentage of literacy was 24 per cent[1] in 1960-61. Amongst males only it was 34.4 per cent, and females 12.9 per cent.

Viewed from this survey of the social background, it is evident that even 15 years hence the finances available compared to the number of persons requiring technical education at all levels will be very small. The number of technical persons required for stepping up the rate of economic growth will increase at a rate faster than the rate of growth of national wealth. It is therefore evident that the policy should be so framed as to make optimum use of available resources by reorienting the present pattern of technical education itself rather than attempting to revolutionize the entire system of technical education.

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[1] 'Third Five-Year Plan—a Draft Outline.' Planning Commission, Government of India, June 1960.

[1] 'India 1963.' Publications Division, Government of India.

Appendix

Paper 1. 'Suggestions for Better Technical Education in India' by Dr. A. K. Chatterjee and Prof. B. S. Rao, para 3.

Paper 2. 'Development of Technical Education for Engineers—Defects in the Existing System and Their Remedies' by B. P. Sarkar, para 2.

Paper 3. 'Whither Engineering Education ?' by N. Sidheswar and N. Rama Rao, sections 2 to 6.

Paper 4. Consensus of Seminar on 'Technical Education and Its Development (1966-81)' held by the Bengal Centre, item (b).

Paper 5. Inaugural Address by Sir Jehangir Ghandy at the Seminar on 'Technical Education and Its Development (1966-81)' held by the Bengal Centre.

CHAPTER IV

PURPOSE AND AIMS OF TECHNICAL EDUCATION

4.1 The aim of technical education, for that matter, all education, is to develop an integrated personality in every person so that he can lead a happy life in an environment of material comfort. In particular, technical education should aim at training well educated and cultured citizens equipped with a knowledge of modern science and technology, capable of skilled work, physically fit and healhy, and imbued with a spirit of patriotism. They should be devoted to their fellow citizens and ready to contribute through their work and their way of life both to the prosperity of the nation and to the cause of peace and amity among the nations. In addition, they should have the capacity to appreciate and have regard for moral values in life. Their minds should be capable of attuning themselves permanently to a state of happiness, no matter what depressing or elevating situtions they may have to face in life.

4.2 Unfortunately, in this country, there is hardly any attempt either at training the student for rational thinking or for training the senses and the muscles for acquiring skill in work. The skill a student acquires should be such as to give him joy in the hours of his leisure and expertness in producing useful products. Those imparting instruction rely mostly on oral explanations and blackboard demonstrations without paying adequate attention to the training of the mind through concrete observations of natural phenomena and laws. Instruction has lacked close contact with practical life. Students hardly taste the joy of making things with their own hands, or of finding that the observations made of natural phenomena in their environment have proved correct. Mental and physical work should be complementary to each other.

4.3 Broadly speaking, technical education at all levels, particularly at the aage group 7-14 years, should, apart from ensuring training in general citizenship as mentioned in para 4.1, concentrate on the fulfilment of the following objectives :

(*a*) To train the mind in a rational way of thinking on any given problem and deducing conclusions in a scientific way.

(*b*) To teach the art of planning in the use of natural resources for economic development, *e.g.*, use of wind to develop power in villages, use of wood for industrial and housing purposes, use of earth for burning bricks, and so on.

(*c*) To develop powers of observation in understanding how nature works and how machines work.

(*d*) To develop manual skill in fabricating products.

(*e*) To develop qualities of discipline to subordinate one's own inclinations to promote the general good of a community, group or the school, or the country itself; to develop qualities of leadership, initiative, capacity to obey, and such other characteristics which will promote social wellbeing of the individual, the community, the country and the world.

(*f*) To use his leisure hours in the development of pursuits which give him happiness and establish harmony and peace in his environment.

4.4 Apart from these general aims technical education should be purposeful. Each stage of technical education, craftsman, diploma and other stages, should be an end in itself so that students breaking off at any stage will be able to make a living from the technical skill they have acquired. They should promote technical development of the country instead of joining the army of the unemployed as the white-collared science and arts educated boys do, specially at the end of the middle school and the high school stages.

4.5 Although self-sufficiency is the aim at each stage of education, preference should invariably be given to those who have covered one stage to get admission to go to the next stage. Curricula for studies should be drawn up with this end in view. This measure will result in giving new dimensions of respectability to craft and other technical education where there are none now. When once it is known that preference is given in admission to those who have already acquired a skill, almost all boys will then be attracted towards technical education so that the best amongst them can always be selected from the previous stage to the next higher stage. Those not selected for admission can earn their livelihood by the craft they have already acquired. The utter despair and the frustration which the S. S. L. C. and the P. U. C. boys now feel when denied admission to technical courses, and the anti-social traits they develop towards the community in general and the Government in particular will not then be there to the extent it is now prevailing.

Appendix

Paper 3. 'Whither Engineering Education?' by N. Sidheswar and N. Rama Rao, sections 1 and 2.

Paper 4. Consensus of Seminar on 'Technical Education and Its Development (1966-81)' held by the Bengal Centre, item (*a*).

Paper 6. 'Technical Education in India and Its Development (1966-81)' by Prof. S. Rajaraman, para 2.1.

Paper 7. 'The Crisis in Engineering Education' by B. Seshadri, paras 11 to 22.

Paper 8. 'The Teaching and Examination Structure of the Five-Year Integrated Degree Courses' by Prof. P. S. Kalwachwala and Prof. A. K. Mehta, sections 2 and 3.

CHAPTER V

STAGES IN TECHNICAL EDUCATION

5.1 At present, activities in spreading technical education may be confined to the following :

5.2 *Giving technical bias* to education at all levels, specially at the elementary school, so that mental and physical work supplement each other. Manual work will then gain new dimensions of respectability.

At present, young children in their classes read books on general science which adults find it difficult to understand. No wonder the science subjects are distasteful to our children. These text-books have to be written emphasizing not so much the content of science as the scientific (rational) way of thinking. The text-books should bring forth mostly the applications of science, like use of electricity for domestic lighting, working small tools used by carpenters and blacksmiths, etc., making and use of fertilizers for lands, and so on, the things with which the child is familiar in his environment. They should bring forth vivid descriptions of the way scientists have exploited natural resources like a waterfall, coal, wood, iron, clay and other materials for the benefit of man. The importance of basic education to the development of our economy cannot be overstressed. Basic education should be understood as the learning of skills to use modern aids to exploit natural resources.

5.3 *Training of skilled craftsmen* : These are the experts who can make any or all the components of an equipment or structure. Technical development to a very large measure depends on the skill of these men. They form the foundation on which technology is built. The training given to them has necessarily to be thorough. Since they form the bulk of the technical manpower of the country, careful and detailed planning is necessary for deployment of these forces in the required numbers, for the required types of jobs, to secure optimum efficiency in their utilization. This problem of training skilled craftsmen is interlinked with the problem of creating gainful employment and preventing underemployment of the vast manpower available in the country.

5.4 *Training of technicians of the foreman type* for erecting, operating, and maintaining small groups of equipment, for example, as in a workshop : They should have thorough familiarity with the operation and maintenance of all the equipment they handle, coupled with an intimate knowledge of the knowhow of erecting them. *Training of master technicians* involves giving a sandwich course where the student has both theoretical training and in-plant training in the plants or projects where they have to start and continue their professional career.

5.5 *Erection and maintenance engineers*: These are meant to specialize in the construction, management and operation of engineering complexes like river valley projects, steel projects, heavy electrical projects, and so on. Training for these men will necessarily have to be broad-based with accent on the practical side.

5.6 *Design and development engineers*: Training for these will be through a post-graduate course of two years. The training should be such that at its end they are in a position to design and develop either independently or working in a team, entirely new equipment based on the technical knowhow in the published literature on the relevant subjects or successfully copy and/or improve prototypes of equipment imported from abroad. This work in the present context of our development is so important that like the Russians, special courses for this purpose leading to conferments of both Master's and Doctoral degrees should be offered. Of the two years, the first year will have to be spent on learning the basic science and engineering subjects, and the second year mainly devoted to the preparation of a design project, which should be defended before a Board of Examiners.

5.7 *Industrialist engineers*: These are trained for starting, developing and managing small-scale engineering industries. Training for these men will have to be through a two-year post-graduate course or a three and a half year post-diploma course leading to the first degree in engineering. In the post-graduate course, the first year should be set apart to teach the elements of cost accounting, labour management, production engineering, marketing and sales promotion, materials purchase, handling and packing, advertising, and such other subjects. The second year of the course will have to be devoted entirely to the study of the design and manufacture of a particular product and submission of a design thesis which the student should defend before a Board of Examiners. In the post-diploma course, the first two years should be devoted to the study of the narrow speciality the manufacture of which interests the student. During the third year, the student should study the same subject as in the first year of the post-graduate course. The last six months of the course should be devoted to the preparation of a thesis devoted to a complete project for starting an industry in his locality. Although there is no such courses in other countries, our own country requires it. In Communist countries, the deployment of technical personnel for starting various types of industries is planned well in advance and controlled entirely by Government. In capitalist countries, giant enterprises tend to act in the same way as governments in Communist countries in deploying technical manpower under their control for the starting or development of newer industries, auxiliary to their main interests. In India, we cannot enforce compulsion as do the Communist Governments, nor do we have cartels which have monopolized industrial production in particular lines. In the social pattern of our objective, it will be necessary to deliberately plan a methodology for starting newer industries in specialized fields calling for a high degree of technical skill in planning, designing, production and marketing.

5.8 *Engineering-scientists*: These are to be trained so that they can give a lead and a direction to technical development. The number required for this work may not be very large but the quality of the work they do will have to be of the highest order. The training of these men should lead to the conferment of a doctorate. There may be five or more methods of taking up these doctoral conferments : (*a*) There may be an integrated course of five years for those who have taken a first degree in engineering, the first two years being spent mostly on learning the basic science subjects and the last three years in a special field of study. Research thesis should be a partial requirements for this type of course ; (*b*) There may be an integrated course of six years for those who have taken a first degree in science, the first three years being spent mostly on learning basic engineering subjects, one year on learning further basic science subjects, and the last two years in at special field of study. Research thesis should be a partial requirement for this course ; (c) There may be an integrated course of three years for those who have taken a post-graduate degree either as a design and development engineer or as an industrial engineer or as a management engineer. The first year of the course will be devoted entirely to the study of the basic science subjects and the other two years entirely to research on an engineering subject. Research is the main requirement for this course ; (*d*) There may be an integrated course of four years for those who have taken their M.Sc. degree in science subjects. The course is the same as for those who have taken their first degree in science except they need not spend an additional year in learning the basic science subjects. Different degrees (D.Eng. and Ph.D), may be given to these categories, each degree denoting the stream through which the doctorate degree was obtained ; (*e*) Any person who has a first degree in engineering or passed an equivalent examination like Sections A and B or the Associate Membership Examination of the Institution of Engineers (India) may submit a thesis either in the form of a design project or a research project for the award of a doctoral degree, after gaining experience for ten years in the profession. This is like an external degree examination such as that of the London University. He has to take written and oral examinations in the relevant subjects, and defend his original contribution in the nature of a design or a research project before a Board of Examiners. A separate degree D. Tech. may be given to such persons.

5.9 *Management engineers* : These are the persons who should have a knowledge of both technology and management. The training for these men should lead to the award of a post-graduate degree in engineering. Admission to these courses should be confined to those who have a minimum of ten years experience in the profession. The course will have to be of two years duration, one year being devoted to the study of relevant subjects like planning and layout of projects, industrial psychology, industrial economics, operational analysis statistical quality control, cost accounting, labour management, and other allied subjects. The second year should be entirely devoted to submission of a thesis on how the candidate proposes to improve the efficiency of any project in actual existence with which he has familiarity, or on any other problem of management. This should be defended before a Board of Examiners.

5.10 *Extension activity to increase productivity in the rural and urban areas* : These include the village agricultural labourer, carpenter, blacksmith, mason, and a host of others. Extension work may consist in holding courses for a week or more to demonstrate the methods of increasing productivity or in the exhibition of feature films in weekly fairs, *jatras, melas,* and other religious and commercial gatherings. Such other methods should be adopted by a separate organization built up for this purpose. Since the number involved may exceed even twenty or thirty millions, the staff and other aids required for the purpose will be colossal. It should not be forgotten that even if the per capita income and the national income gets increased by a few rupees per each individual the sum total will be substantial.

5.11 *Technical education for women at home*: Their number runs to well over a hundred million. There is considerable underemployment amongst them. Suitable extension work will have to be evolved, so that they too can add both to their per capita income and to national wealth.

5.12 *Extension work for those already in employment*: Everybody should be given an opportunity to improve his learning from the lowest to the highest levels. With this end in view, correspondence courses, short refresher courses, seminars, and such other courses should be conducted. External degrees, diplomas certificates, or other forms of conferment should be given to those who successfully undergo them. This is another very commendable method of increasing productivity with minimum cost.

5.13 *Technical education for the physically handicaped*: Courses to suit these will have to be drawn up and offered in institutes specially run for this purpose.

5.14 *Other specialized courses*: These are varied in type but the requirement of each type is very small. Examples of these types are, engineers specializing in designing and making surgical instruments and other requirements for medical men, engineers for designing and making aids for physically handicapped persons, engineers for designing and fabricating equipment required for sport, games and toys, engineers for designing and fabricating equipment for museums, exhibitions, and so on. These courses can be offered in industrialist engineer courses.

5.15 *Technical education for military requirements*: This is discussed at length in Chapter XIX.

Appendix

Paper 4. Consensus of Seminar on 'Technical Education and Its Development (1966-81)' held by the Bengal Centre.

Paper 6. 'Technical Education in India and Its Development (1966-81)' by Prof. S. Rajaraman, paras 4.2 and 4.3.

Paper 9. 'The Aims of Technical Education and Their Relation to Curriculum' by Prof. J. P. Joshipara.

Paper 10. 'Purpose and Aims of Technical Education' by S. K. Datta.

CHAPTER VI

TECHNICAL BIAS TO GENERAL EDUCATION IN ELEMENTARY AND SECONDARY SCHOOLS

6.1 *The nursery school* for the age group 3-6 years is meant to assist the physical development of the child and to teach him good habits of cleanliness, orderliness and healthful living, and inculcate the practice of appreciating things beautiful. The child is taught to express himself clearly and enlarge his concepts regarding his own home and its environment. *He is taught to respect work*, to be friendly with other children, and to be polite to elders. Most of the teaching is done through play. Games are arranged in such a way as to reflect most accurately the varied aspects of real life and to highlight importance of teamwork. Girls are taught to make dolls and other simple things with clay, while boys are encouraged to build simple structures like a house, a car, an electric pole, etc. with clay or other materials at hand. A lot of time is given to singing, dancing, drawing, modelling, film shows and puppet shows. Particular care is taken that the children spend as much time as possible in outdoor activity.

6.2 At the elementary, middle and high school stages, pupils have to be given a basic knowledge in arts, science and technology. Educationists and teachers have to provide them with an all-round basic education, while they must avoid overburdening the students with an excessively wide range of subject matter. At this stage, during the ten years of schooling, a student has to study the following subjects : (*a*) the mother tongue, (*b*) Hindi, (*c*) English, (*d*) Civics and History, (*e*) Geography, (*f*) Mathematics, (*g*) Physics, (*h*) Chemistry, (*i*) National Sciences, (*j*) Physical Education, (*k*) Art Education, including geometrical drawing, and (*l*) Craftsmanship. The present syllabi in the languages and the humanities are adequate. In mathematics, emphasis should be laid during the first five years on mastering the four basic arithmetical processes, units of measurement, and on independent solution of problems. During the next six years, arithmetic including algebra should be given more prominence, and geometry should include elements of solid geometry. New text-books should be written, emphasizing numerical calculations so that geometry is not studied in the abstract way as it is now being done. Its importance in everyday use in industry engineering and science, and commerce should be brought out while teaching.

Physics should embrace fundamentals of meteorology, astronomy, radio technology and nuclear physics. Teaching of physics should be based *primarily* on demonstration by *models* and actual experiments by students and excursions.

The teaching of chemistry should include fundamentals of organic chemistry and inorganic chemistry, the emphasis being on organic chemistry and basic chemical production processes. The present emphasis on physical and inorganic chemistry should be reduced considerably.

Drawing and solid geometry should be taught together. These subjects are intended to develop the student's spatial perception and capacity to make drawings and designs of simple technical details.

A very important part of the curricula is the bringing of the school closer to actual life. It should be compulsory for the teachers to set apart two half-days in the week for this purpose. The teachers should take out teams of boys on excursions for the observation of production processes. This may consist in systematic observation, week by week, of agricultural farming and processing methods, or manufacture of products in a factory, or construction of buildings starting from their foundation to their completion, and such others. At the end of each term, the boys should be encouraged to write out reports of what they have seen.

6.3 In this context, the example of Czechoslovakian schools may be quoted. These are of three years duration and can be adopted for the IX, X and XI standards of our higher secondary courses.

Curriculum of the General Secondary School in Czechoslovakia

Bias	General Education		Mathematics-Physics Year and hours per week		Chemistry-Biology	
Subject	1, 2, 3	Total	1, 2, 3	Total	1, 2, 3	Total
1. Czech language and literature	4, 3, 3	10	As for general education			
2. Russian language	2, 2, 2	6	"			
3. Third modern language (German, English, French or Spanish)	3, 2, 3	8	"			
4. History	2, 2, 2	6	"			
5. Geography	2, 2, —	4	"			
6. Civics	1, 1, 1	3	"			
7. Mathematics	4, 4, 4	12	5, 5, 5	15	4, 4, 4	12
8. Geometry	—		— 2, 2	4	—	
9. Physics	3, 3, 4	10	3, 4, 5	12	2, 3, 3	8
10. Chemistry	2, 2, 3	7	3, 2, —	5	3, 3, 4	10
11. Biology	2, 2, 1	5	— — 2	2	2, 3, 3	8
12. Physical Education	3, 3, 3	9	3, 3, 3	9	3, 3, 3	9
13. Fundamentals of Production	8, 8, 8	24	8, 8, 8	24	8, 8, 8	24
Optional subjects						
1. Descriptive Geometry	— 2, 2	4	—		—	
2. Laboratory work in Chemistry and Biology	— 2, 2	4	—		—	
3. Geology and Mineralogy	— 2, 2	4				
4. Art Education	— 2, 2	4				
Total	36,36,36	108	36,36,36	108	36,36,36	108
Non-compulsory subjects						
1. Conversation in a modern language	2, 2, 2	6	2, 2, 2	6	2, 2, 2	6
2. Latin	2, 2, 2	6	—		2, 2, 2	6
3. Art	—		2, 2, 2	6	—	
4. Technical Drawing	2, 2, 2	6	—		2, 2, 2	6
5. Laboratory work	2, 2, 2	6	2, 2, 2	6	2, 2, 2	6
6. Sports and Games	2, 2, 2	6	2, 2, 2	6	2, 2, 2	6

Appendix

Paper 7. 'The Crisis in Engineering Education' by B. Seshadri, paras 10 to 15.

Paper 11. 'Pattern of Technical Education and Its Development' by R. Venkataraman, sections 2 to 5.

CHAPTER VII

CRAFTSMEN TRAINING

7.1 *Higher Secondary Technical Schools*: At present, most of the craftsmen in the country are illiterate and have hardly any general knowledge.

The establishment of Industrial Training Institutes has no doubt been a step in the right direction in training craftsmen. As the duration is only 18 months, all teaching is only of one draft. General education is neglected. Generally, boys above 16 years of age attend these Institutes. These boys are those who have failed to pass even the S.S.L.C. examination. The intellectual calibre of the boys taking these courses is therefore low.

It is better to start technical training when the boy is about 13 years of age, when he will have finished seven years of education, that is, the VII standard. He can then study for the next four years at the end of which he will have gained sufficient proficiency in a trade to get employment.

7.2 *Practice in Russia*: This has been discussed with reference to a course in mining.[1]

A Soviet seven-year school graduate (age 14) will have had seven years of mathematics, four years of biology, two years of physics, one year of chemistry, three years of foreign language, and one year of mechanical drawing. In mathematics, the student will have studied (*a*) Arithmetic—6 years at the rate of 6 or 7 hours per week for the first 5 years and 2 hours per week in the VI class; (*b*) Algebra—2 years at the rate of 3 hours per week in VI and VII classes; and (c) Plane Geometry—2 years at the rate of 2 hours per week in VI and VII classes.

The following table summarises the subjects included in the curriculum. Of the total 4,682 hours of scheduled instruction, some 36 per cent (1,685 hours) is allotted to lectures, and the rest of the hours to shop, laboratory, field and group work.

U.S.S.R. (1951)

Category of subjects	Four-year course		Lectures only	
	Hours	Per cent	Hours	Per cent
General (History, Russian and foreign language)	767	16.4	301	39
Science (Mathematics, Physics and Chemistry)	726	15.5	250	34
General Technical (Drawing, Mechanics and Electricity)	704	15.0	268	38
Specialised Technical	1,717	36.7	865	50
Shop and field work	582	12.4	—	—
Physical culture	186	4.0	—	—
Total in four years	4,682	100.0	1,685	36

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[1] 'Soviet Education for Science and Technology' by Alexander G. Korol. *John Wiley & Sons, Inc.*, 1957.

In addition to the scheduled hours of instruction, the curriculum provides from 26 to 30 weeks of summer employment, presumably related to the field of specialization.

A conspicuous feature of the curriculum is its heavy concentration on narrowly specialized vocational subjects.

7.3 *Topics geared to the requirements of a specific job take up 50 per cent of the time* : In Czechoslovakia, the system adopted is more or less similar to Russia. The following is an example of the teaching plan of the secondary vocational schools in machine technology.

Czechoslovakia

Subjects	Years				Total
	I	II	III	IV	
Czech language and literature	3	2	2	2	9
Russian History	2	2	2	2	8
History	2	2	—	—	4
Economic Geography	—	—	2	—	2
Civic education	1	1	1	1	4
Political economy	—	—	2	—	2
Mathematics	5	3	3	—	11
Physics	4	—	—	—	4
Chemistry	4	—	—	—	4
Physical Training	3	3	3	2	11
Electrotechnics	—	3	2	—	5
Technical Drawing	4/2	3	—	—	6
Mechanics	1/2	4	3	—	8
Machine parts	—	6	5	—	11
Machines	—	—	4	8	12
Technology	2	3	3	8	16
Organization and Economics	—	—	—	4	4
Laboratory exercises	—	—	—	4	4
Psychology and Hygiene	—	—	—	1	1
Manufacturing Practice	6	4	4	4	18
Total	36	36	36	36	144
Non-compulsory subjects					
Further living language	2	2	2	2	8
Mathematics	—	—	—	2	2
Physics	—	—	2	—	2
Games	2	2	2	2	8

It will be seen that in an underdeveloped country (underdeveloped compared to Russia), heavy emphasis is always placed on technology.

7.4 Studying conditions in our own country, the Russian pattern seems to be better, as there is a better balance in the curricula between humanities, science and technology. The Institute of Manpower has listed 52 trades both in the engineering and the non-engineering groups. It is not desirable to teach more than *one of these crafts* in the vocational Higher Secondary Technical School. The emphasis has to be on acquirement of skill and not on general knowledge in a variety of subjects. The following are a few examples from the list : (*i*) blacksmith, (*ii*) carpenter, (*iii*) electrician, (*iv*) fitter, (*v*) grinder, (*vi*) wireman, (*vii*) machinist, (*viii*) mechanic—instruments, (*ix*) mechanic—motor, (*x*) mechanic—refrigerator, (*xi*) mechanic—internal combustion engines, (*xvi*) turner, (*xvii*) welder (gas and electric), (*xviii*) plumber, (*xix*) mechanic—tractor, (*xx*) die fitter, (*xxi*) lineman, (*xxii*) draughtsman—civil, (*xxiii*) draughtsman—mechanical, (*xxiv*) electroplator, (*xxv*) mechanic—radio, (*xxvi*) painter and decorator, (*xxvii*) mason—brick and stone, (*xxviii*) mason—reinforced concrete, (*xxix*) wireless operator, (*xxx*) upholsterer, (*xxxi*) watch repairer, (*xxxii*) surveyor, (*xxxiii*) bleaching, dyeing and calico printing, (*xxxiv*) book-binding, (*xxxv*) cutting and tailoring, (*xxxvi*) embroidery and needlework, (*xxxvii*) handweaving of fancy furnishing fabric, (*xxxviii*) hand composition and proofreading, (*xxxix*) handweaving of woollens and silk, (*xl*) knitting (hand and machine), (*xli*) footwear manufacture, (*xlii*) household utensils manufacture, (*xliii*) sports goods—leather, (*xliv*) sports goods—wood, (*xlv*) sports goods—other materials, (*xlvi*) suitcases and other leather goods, (*xlvii*) preservation of fruits and vegetables, (*xlviii*) printing machine operation, (*xlix*) handweaving of *newer*, tape, druggets and carpets, (*l*) stenography, (*li*) cane and bamboo work, and (*lii*) block-making.

The list is by no means exhaustive as it does not contain any of the skills to be acquired in agriculture, fishing, and other professions. The list exceeds 500 trades or crafts in developed countries. As many of them as possible should be introduced and taught for a period of four years.

7.5 The existing Industrial Training Institutes can be used for this purpose. *The success of this scheme depends entirely on the scope given for higher training after completion of this course.* For this purpose, *preference* should be given to these students in the matter of admission to both diploma and degree courses in engineering.

As the knowledge in the humanities and the science courses will be up to the S.S.L.C. level (X standard), there should be no difficulty in giving them training for a diploma course in two and a half years. The half-year may be utilized in giving them training in English and the basic science subjects. The next two years should be devoted to engineering subjects. Syllabi for these boys will have to be different from other courses leading to the diploma (see Chart 1).

They can also be admitted straight to the first degree courses. The first two years of the course will have to be spent in learning the basic science subjects and English. The other three years will be utilized in teaching the relevant engineering subjects. Syllabi of the courses for these boys will have to be different from other courses (see Chart 1, page 62)

Appendix

Paper 12. 'Technical Education for Industries with Special Reference to Paper Mills' by J. R. Sen.

CHAPTER VIII

TECHNICIANS' TRAINING

8.1 Technicians of the foreman or the overseer type are required in large numbers for erecting, operating and maintaining small groups of equipment, *e.g.*, a general repair workshop, construction of buildings, factory manufacturing different varieties of pumps and other turbo-machines, etc. They should have thorough familiarity with the operation and maintenance of all the equipment they handle, coupled with an intimate knowledge of the knowhow of erecting them. The diploma courses should be looked upon as a continuation of craftsmen courses in a more intensified and enlarged form and *not as a condensed or a simplified course of the first degree in engineering*. The training all along has been to give a simplified version of a degree course with the result the diploma course has been a failure. The students passing out of these courses do not have the knowledge necessary to take up the type of design, planning and execution of works which the engineers are expected to do. They do not also have that intimate knowledge of crafts which can enable them to give technical guidance to craftsmen. Generally, they are looked down with contempt both by the engineers above them and the workmen under them. This lasts for several years till they pick up enough practical experience to guide workmen. The more intelligent amongst them, by self-study at home, manage to learn design and planning work. Such of these have proved themselves in no way inferior to graduates. These exceptions are rare and few. The credit for this achievement is largely self-earned and is in no way due to the training they have received in their polytechnics.

8.2 The type of students attracted to these courses are mostly below average in scholastic achievements. This is because these courses do not afford any opportunity to acquire higher learning. If the diploma courses are to succeed, four reforms are essential: (*a*) the training should be to give a superior and higher form of craftsmen training; (*b*) preference should be given to these boys in the matter of admission to the degree courses; (*c*) a separate scheme and syllabi for the courses have to be drawn up for the training of these boys for the degree courses; and (*d*) separate syllabi should be devised so that the three streams of students completing the VII standard of education are enabled to work their way to diploma courses (see Chart 1).

8.3 *Technician training in the U.S.S.R.*: Till very recently, training of craftsmen started with students who had completed seven years of elementary education. In 1952, two to two and a half years courses were organized for students who had completed ten years of schooling. These are trained in technicums.[1] An official handbook defines technicums in the various categories as follows:

Industrial (and construction) technicums train (*i*) mining technicians, (*ii*) technician metallurgists, (*iii*) technologists, (*iv*) mechanics, (*v*) electricians, (*vi*) electromechanics, (*vii*) constructors, (*viii*) heat technicians, (*ix*) chemists, (*x*) radio technicians, (*xi*) builders, (*xii*) hydro technicians, and (*xiii*) other specialists for the various branches of industry and construction.

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[1] 'Soviet Education for Science and Technology' by Alexander G. Korol. *John Wiley & Sons, Inc.*, 1957.

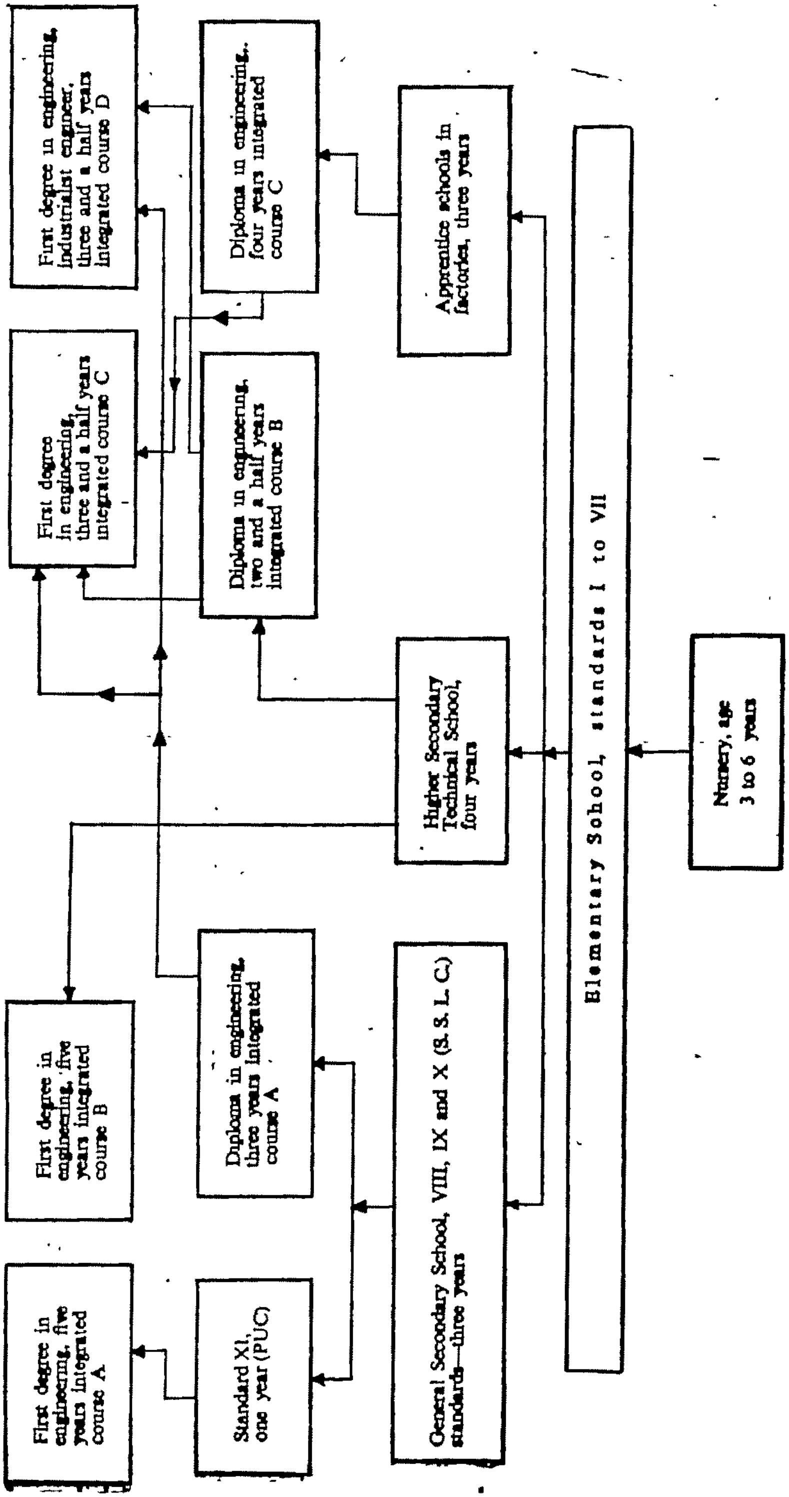
First degree in engineering, five years integrated course A
First degree in engineering, five years integrated course B
First degree in engineering, three and a half years integrated course C
First degree in engineering, industrialist engineer, three and a half years integrated course D
Standard XI, one year (PUC)
Diploma in engineering, three years integrated course A
Diploma in engineering, two and a half years integrated course B
Diploma in engineering, four years integrated course C
General Secondary School, VIII, IX and X (S. S. L. C.) standards—three years
Higher Secondary Technical School, four years
Apprentice schools in factories, three years
Elementary School, standards I to VII
Nursery, age 3 to 6 years

CHART 1

Transport technicums train (*i*) technician mechanics, (*ii*) electricians, (*iii*) operating technicians, (*iv*) track technicians, (*v*) boat mechanics, (*vi*) quartermasters, (*vii*) automotive mechanics, and (*viii*) other specialists for railroad, automotive, marine and river transport.

Communications technicums train (*i*) electrical technicians for wire communications, (*ii*) radio technicians, and (*iii*) technicians for postal services.

There are also other categories of technicums (economic, agriculture and forestry, pedagogical, library, medical and art).

The available graduation statistics show that the number of industrial and construction technicum graduates has been rapidly increasing. In 1955, there were 387.8 thousand graduations, out of which 140.8 thousands or 36.3 per cent of the total were graduations in industrial and construction technology.

The recent expansion of the total technicum enrolment, and particularly in the industrial and construction technicums, is partly accounted for by *an increase in part-time evening enrolment and in the number of correspondence studies*. In 1955, of the total 245.5 thousands matriculated at industrial and construction technicums, 48.6 thousands (20 per cent) were part-time evening students and 36.2 thousands (15 per cent) were students by correspondence.

The following was the distribution of graduates by fields of specialization in 1955.

Field of specialization	Number in thousands	Per cent
Geology and exploration of deposits	5.6	1.4
Development of geological deposits	13.0	3.4
Power industry	12.7	3.3
Metallurgy	4.5	1.2
Machine and instrument construction	34.9	9.0
Electrical machines and instrument construction	4.8	1.2
Radio engineering and communication	11.9	3.1
Chemical technology	7.2	1.9
Wood, pulp and paper technology	5.1	1.3
Construction	32.4	8.3
Transportation	12.6	3.2
Consumer food-products technology	5.7	1.5
Consumer goods technology	5.9	1.5
Geodesy and cartography	1.4	0.4
Hydrology and meteorology	1.1	0.3
Total of the above	158.8	41.0
Agriculture	50.4	13.0
Economy (trade and services)	41.6	10.7
Legal	1.3	0.3
Health and physical culture	59.6	15.4
Education	70.2	18.1
Arts	4.2	1.1
Miscellaneous	1.7	0.4
Total	387.8	100.0

At present, there are 1.5 technicians for every engineer. The idea is to increase the ratio of technicians to engineers by training 'for each specialist of higher qualification not fewer than two to four specialists of medium qualification'.

These technicums, mostly one for each branch of specialization, are located usually at the places where factories which need these persons most are existing.

Technical training is mainly terminal. It is not designed as preparation for further higher education. The top 5 per cent can apply and get admission to degree courses. The training is largely confined to acquiring specialized skills for limited vocational functions.

8.4 *Technician training in the U.K.*: In the U.K., there has hardly been any planning. Most institutions have grown over the years in response to the expressed and anticipated needs of the local industries and the community generally.[1] In coastal areas, the most characteristic are the departments and courses to deal with sea-going traffic such as Departments of Navigation, Marine Engineering, and Naval Architecture. In the ports are also to be found wideranging courses in business, commerce, economics, banking and languages and such specialist subjects like port organization and finance, shipping, shipbuilding, exporting and forwarding. In the coalfields, there are courses in mining, and near iron and steel industry, there are courses in iron and steel manufacture, metallurgy and engineering, ceramics, and so on. Similarly, courses were started in leather, textile, chemical and other industrial areas. *The advantage of an early start of full-fledged institutions even before the industries fully developed* when coupled with the introduction of machines and mass production, *led to world trade for transcending the local supply of raw materials and needs upon which the industry was founded.*

The duration of the courses after Matriculation varies from two to three years. The standards vary considerably. Certificates are issued from colleges like the City and Guilds of London Institute, and National Certificates and Diplomas, and Higher Diplomas are also awarded by the Government.

8.5 Here, diploma courses have come to stay. They fulfil a very important role in the training of technical craftsmen. Till now, the skilled craftsman was an illiterate person. As a result of the recommendations made here, it is hoped the skilled craftsmen will be those who have received general education up to the level of the VII standard. It will be decades before we can hope to have skilled craftsmen with a basic education up to the S.S.L.C. standard. That is possible only when education is almost, if not entirely, free and compulsory up to the S.S.L.C. level. Till then, we have to have two types of craftsmen, one the ordinary craftsmen and another the technician who knows enough of the crafts to supervise the work of the craftsmen. These supervisors are the men with diploma qualifications.

For the first stream, the duration of the diploma course should be of three years for those who have completed their S.S.L.C. course (X standard). For the second stream, it can be of two and a half years duration for those who have passed out of the four-year Higher Secondary Technical School course, the first half-year being spent in teaching the basic sciences and the languages which may not have been adequately covered earlier. The third stream will comprise students who join factories after completing the VII standard and have undergone a three-year apprentice school course in a factory. For these, the diploma course will have to be of four years duration, the first two years being devoted mostly to the study of the sciences and the languages. These courses may be sandwich courses.

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[1] 'Technical Education' by P.F.R. Venables. *G. Bell and Sons, Ltd.*, 1956.

Appendix

Paper 13. 'Training and Education for Technicians' by A. S. Sen and P. K. Mukherjee.

CHAPTER IX

ERECTION AND MAINTENANCE ENGINEERS : FIRST DEGREE COURSE IN ENGINEERING

9.1 *Erection and maintenance engineers :* These are meant to specialize in the construction, management and operation of engineering complexes like river valley projects, steel projects, heavy electrical projects, and so on. Engineers who have adequate knowledge in civil, mechanical, electrical and other branches of engineering are required to work individually or in a team with others. Training for these men will have to be broad-based, with accent on the practical side. The number required of this type has necessarily to run to thousands. This is also the basic degree which should lead to training of design and development engineers, industrial engineers, consulting engineers, management engineers, engineer-scientists, and other types of specialists.

9.2 *Practice in the U.S.S.R. :* Soviet civilian institutions of higher education include two general types[1], the universities, of which there were 34 in 1956, and the institutes, a general category embracing more than 729. The distinction between the two types rests mainly on the fact that the courses of study in the universities are organized more or less horizontally within and around a given major field (*e.g.*, physics, chemistry and mathematics), whereas those in all other types of schools (institutes) are geared to the specific requirements of a particular industry (*e.g.*, mining, aviation, printing industry or a well defined vocation *e.g.*, high school teaching of mathematics, agronomy). The distinction between the universities and all other types of Soviet institutions of higher learning might be further indicated by the fact that it is only in the universities that each basic science such as physics or chemistry or mathematics constitutes a field of speciality.

The following gives the number of institutions of higher education in 1955 listed by categories and types of instruction. The letter E before the category shows that the institutes have an evening department, the letter C indicates a department of instruction by correspondence, and the letter F indicates fulltime courses.

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[1] 'Soviet Education for Science and Technology' by Alexander G. Korol. *John Wiley & Sons, Inc.*, 1957.

Categories	Type of instruction	Number
Universities	FEC	33
Institutes		
Polytechnic	FEC	20
Industrial	FEC	5
Power	FE	3
Electrotechnical	FE	2
Radio	FE	2
Physics	FE	1
Machine construction, machine tools and tools, mechanical and automotive	FE	16
Shipbuilding	FE	2
Aviation	FE	7
Polygraphic	FE	3
Motion picture engineering	FC	1
Geology mining, oil and peat	FEC	15
Metallurgical and mining metallurgical	FEC	11
Chemical technology	FEC	9
Food industries	FEC	9
Fishing industries	FEC	4
Light industry	FEC	3
Textile	FE	5
Engineering construction	FEC	19
Geodetic	FC	2
Automotive highway	FEC	6
Hydro-meteorology	FEC	2
Railroad transport	FE	13
Water transport	FEC	4
Marine and navigation	FC	4
Civil air fleet	F	1
Communications	FE	5
Agricultural	FC	63
Animal husbandry, milk veterinary	FC	21
Mechanization and electrification of agriculture	FEC	7
Water resources development and land management	FC	6
Forest and forest technology	FEC	11

The Soviet Union also maintains military schools for training in engineering and applied sciences at advanced levels.

The primary unit of academic organization in any institution of higher learning is the '*chair*' (chair corresponds to department here) of a given academic discipline such as chair of semiconductors and dielectrics, chair of machine tools, etc. The professor in charge of the chair, whose appointment is subject to confirmation by the Ministry of Higher Education, directs both the academic and research work of the professors, docents (these correspond to assistant professors and readers in India), assistants, and post-graduate students attached to the chair. Post-graduate students are attached to a particular chair. There are faculties which consolidate the work of a number of chairs of undergraduate and post-graduate instruction in a particular field. The name of the faculty more or less accurately designates its field, *e.g.*, mechanical faculty and welding faculty. Students are encouraged to work in narrow specialities. An undergraduate student, for example, specializing in 'geophysical methods of search and prospecting for deposits of useful minerals' can further specialize in one of the following: 'geophysical methods or prospcting for ore and non-ore deposits' or 'geophysical methods of prospecting for oil, gas and coal deposits' or 'geophysical methods for the exploration of wells'. By 1932, these specialities in engineering alone numbered 330. *At one time, there were* 111 *specialities in just one branch of mechanical engineering and that was in machine design.* There are 232 faculties and 534 specialities in 33 universities, and 132 faculties and 392 specialities in 167 industrial institutes and polytechnics. *There are* 16 *institutes which teach only machine construction, machine tools and tools.*

9.3 *Practice in the U.K.* : It is felt in the U.K. that technological education is in need of drastic changes, specially at the degree levels.[1] 'A great deal remains to be done. This applies to both science and technology *but particularly to the latter*. Our first-hand study of some of the great institutions overseas has left us in no doubt of this ; and comparative statistics show that in Britain, within the total field of science and technology, less emphasis is given to technology and more to pure science than in any of the other countries. Moreover, our student survey showed that science not only attracts greater numbers but also attracted better quality than does technology. In research, too, technology lags behind and once again, this country suffers in comparison with others. This is a question of volume rather than quality our best research in technology can stand comparison with similar research anywhere in the world but it is inadequately supported from both public and private sources. We therefore recommend that a major effort should be made to encourage an increase in technological as well as scientific research'. The Robbins Committee has further recommended starting of 'Special Institutions'. 'Their main emphasis should be on technology in partnership with science'. They want that emphasis in these institutions should be on science and technology. But other related subjects such as social studies, operational research and statistics should be developed on a significant scale, and languages will be needed at least as ancillary subjects. Secondly, they want these Special Institutions should be large, so as to cover a wide range of subjects with an appropriate divison of labour within each. Thirdly, *they want these must have a strong emphasis on post-graduate studies ; post-graduate students should form about half the student body.*

The first degree course in engineering is generally one of three years duration after Matriculation. These are very general courses covering much less than is usually covered in Indian engineering colleges.

9.4 The present first degree course in engineering is very well balanced between the requirements of humanities, basic science, basic engineering, and general knowledge in one wide branch of engineering. These are the essential minimum requirements for an engineer. The course has been evolved after decades of experience and may be generally retained in their present form. Recently, it has been modified giving a greater quantum of knowledge in the basic sciences. This is in keeping with the developments in science that have taken place specially after the Second World War. Since the prime objective of this course is to train engineers for doing mostly erection and maintenance work, it is necessary that the present syllabi should be modified to lay *greater emphasis on the practical aspects of the profession.*

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[1] 'Higher Education'. Report by Lord Robbins' Committee. Her Majesty's Stationery Office, London, 1963-64.

In the present context of technical development in this country, it is not desirable to have a very narrow and high degree of specialization at the first degree level itself as in the U.S.S.R. The following four streams of entry to the first degree course in engineering (see Chart 1) may be introduced. The syllabi for these four shall necessarily have to be different.

For the first stream, the course has to be of five years duration for those passing out of Higher Secondary Technical Schools. The syllabus for this course has to be different from the other streams, though the total quantum of knowledge covered in all these syllabi can remain almost the same.

The second stream leading to the first degree in engineering is from the Higher Secondary Schools and the course will be of five years duration. The present syllabus is all right except in the final year where a course in production methods, materials handling and erection should be made compulsory for students in all branches of engineering.

The third stream leading to the first degree is from those who have taken a diploma course. As these students have already undergone a course in engineering, it is unnecessary to repeat courses in drawing, workshop and other subjects already covered in the diploma courses. The first six months is a preparatory course for teaching English language, physics, chemistry and mathematics. The next three years may be devoted to teaching the same subjects taught in the other streams. Separate syllabi for this course are also necessary. The length of this course will thus be three and a half years.

The fourth stream is described in para 11.2 of Chapter XI describing the industrialist engineer.

At present, the first degree courses in engineering are limited to only civil, mechanical, electrical, telecommunication, chemical, metallurgy and mining courses. These cover such a wide field that a student after he enters the profession has hardly any chance of making use of knowledge in many of the subjects he studied in the college. For example, a civil engineer wishing to take up building and other civil engineering construction as his career, can hardly make use of his knowledge in highway engineering, railways, harbours and tunnels. Courses in civil engineering at present can be split into three broad fields : (*a*) one dealing with all aspects of construction, like construction and design of buildings, dams and other structures ; (*b*) a second dealing with all aspects of communication and design like highways, bridges, docks, harbours, tunnels, air ports, railways, etc. ; and (c) dealing with all aspects of the use of water resources, sanitary engineering, water supply, hydraulics, irrigation and drainage, water power engineering, etc. Similarly, mechanical engineering can be split up into broad areas like (*a*) workshop technology including management, production, general principles and design of workshop equipment and tools ; (*b*) heat power engineering including elementary design, generation, transmission and utilization—steam, diesel, gas or other fuel ; (*c*) aeronautical engineering including elementary design of planes ; (*d*) agricultural engineering including elementary design of agricultural machinery ; (*e*) shipbuilding ; (*f*) automobile engineering ; (*g*) general machine construction ; and (*h*) precision instruments and instrumentation.

The number of courses to be offered for the first degree should be enlarged manyfold. Each course should cover only broad areas, no attempt being made at specialization in narrow fields.

Appendix

Paper 8. 'The Teaching and Examination Structure of the Five-Year Integrated Degree Courses' by Prof. P. S. Kalwachwala and Prof. A. K. Mehta.

CHAPTER X

DESIGN AND DEVELOPMENT ENGINEERS : POST-GRADUATE COURSES IN ENGINEERING

10.1 Training for design and development engineers will be through a post-graduate course of two years duration. The training should be such that at the end of their training, they are in a position to design and develop either independently or working in a team either entirely new equipment, or successfully copy/or improve prototypes of equipment imported from abroad. This work is so important that like the Russians, special courses for this purpose leading to conferments of both Master's and doctoral degrees should be offered. Of the two years in this course, the first year should be devoted to learning the basic science and engineering subjects necessary for specializing in a very narrow field. The second year should be devoted to the studies necessary for preparing a design project and the preparation of the project itself. The studies necessary for the preparation of the project thesis may be prepared in the college and/or in a factory. This project should be defended before a Board of Examiners. The Board should consist of both men with sound academic knowledge of the subject and those who have practical experience in a factory or a project.

10.2 *Practice in the U.S.S.R.* : In para 9.2, detailed description of the courses offered, the institutes and the chairs concerned with the teaching of these courses have been described. It has been mentioned therein that there are 232 faculties and 534 specialities in 33 universities, and 132 faculties and 392 specialities in 167 industrial institutes and polytechnics. There are 16 institutes which teach only machine construction, machine tools and tools. All these specialities are taught at the first degree level itself.

10.3 *Sample curricula compared with the U.S.S.R. and the U.S.A. systems:*[1] 'The specific curriculum presented here as a sample of a Soviet course in mechanical engineering, represents perhaps the most advanced Soviet plan of training engineers in the speciality defined as 'Technology of Machine Construction, Metal Cutting Tools and Tools'. The curriculum for training at the Bauman Higher Technical School provides for 4,848 scheduled class hours of instruction distributed within a five-year course approximately as follows :

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[1] 'Soviet Education for Science and Technology' by Alexander G. Korol. *John Wiley & Sons, Inc.*, 1957.

Year of course	Scheduled class hours	
	M.V.T.U. in U.S.S.R.	M.I.T. in U.S.A.
Second	1,105	750
Third	973	615
Fourth	768	585
Four years total	4,068	2,610
Fifth	780	——
Total	4,848	

The total time of the M.V.T.U. curricula is allocated by types of instruction as follows :

Curricula	Hours	Per cent
Lectures	2,632	54.3
Laboratory work	595	12.3
Practical work, seminars, exercises, etc.	1,303	26.9
Term projects and papers	318	6.5
Total	4,848	100.00

A comparative listing of subjects graphically points up the Soviet emphasis on specialization and on extensive and intensive training in what appears to be largely vocational and industrially oriented knowledge and techniques. It will also be noted, for instance, that three subjects in metallurgy and technology of metals (253 hours) in the M.V.T.U. curriculum are placed *versus* one required course, engineering metals (90 hours), at the M.I.T. Even a more striking contrast is provided by the fact that the M.V.T.U. curriculum includes a large number of subjects dealing with various types of tools and equipment for which there are no counterparts in the basic curricula of mechanical engineering at the M.I.T., including the majority of the M.V.T.U. subjects of the 'present art' type such as 'Materials Handling, Machinery and Mechanisms'. As to the specialized but fundamental engineering subjects which are included in the M.V.T.U. curriculum but do not appear in the M.I.T. list, it should be noted that a large number of elective subjects is available to an American engineering senior, permitting him to begin specialization in any one area within his general field during the last year of undergraduate work'.

The following are the further details of the syllabus in 'Technology of Machine Construction, Metal Cutting, Machine Tools and Tools'. This is given in comparison with the M.I.T. curriculum in the U.S.A.

Summary	M.V.T.U.	M.I.T.
Course of instruction years	5	4
Weeks of class instruction	153	120
Scheduled class hours	4,848	2,610
Class hours per week (average)	31.7	21.7
Industrial practice weeks	24	Nil

M.V.T.U. (U.S.S.R.)			M.I.T. (U.S.A.)		
Subject	Hours	Per cent	Subject	Hours	Per cent
Higher Mathematics	388	8.0	Calculus	135	5.2
			Differential Equations	45	1.7
Physics	245	5.0	Physics	300	11.5
Chemistry, General	120	2.5	Chemistry, General	180	6.9
Theoretical Mechanics	214	4.4	Applied Mechanics	150	5.8
			Fluid Mechanics	60	2.3
Heat Engineering	78	1.6	Heat Engineering	105	4.0
Descriptive Geometry	90	1.9			
Machining Drawing	188	3.9	Freshman Elective Machine Drawing	90	3.4
Strength of Materials	232	4.8	Strength of Materials	45	1.7
			Mechanical Behaviour of Materials	60	2.3
Theory of Mechanisms and Machines	198	4.1			
Machine Details	215	4.4	Machine Design	195	7.5
Hydraulics and Hydraulic Machinery	48	1.7	Industrial Hydraulic Machinery (Design)	75	2.9
General Electrotechnics and Measurement of Non-Electric Magnitudes	190	3.9	Electrical Engineering Foundations	60	2.3
			Engineering Laboratory	60	2.3
Physical Metallurgy and Thermal Treatment of Metals	84	1.7	Engineering Metals	90	3.5
Technology of Metals (Metallurgy and Hot Fabrication)	118	2.4			
Thermal Treatment of Machine Details	39	0.8			
Shop Training	204	4.2	Machine Tools, Introduction	60	2.3

Table (*continued*)

Metal Cutting, Machine Tools and Automatics	337	7.0			
Hydraulic Equipment in Machine Tools	56	1.2			
Electrical Equipment in Machine Tools	65	1.3			
Machine Construction Technology	208	4.3	Machine Tools, Fundamentals	45	1.7
Construction of Mechanical Equipment	39	0.8			
Interchangeability and Technical Measurement	68	1.4			
Materials Handling Machinery and Mechanisms	116	2.4			
Metal Cutting	80	1.6			
Metal Cutting Tools	221	4.6			
Planning of Machine Building Shops and Elements of Structural Engineering	65	1.3			
Automation of Industrial Processes	65	1.3			
Industrial Economics, Organization and Planning of Enterprises	91	1.0			
Safety and Fire Protection Engineering	39	0.8			
History of Engineering	39	0.8			
Marx-Leninism	252	5.2	Mechanical Engineering Problems	45	1.7
Political Economy	140	2.9	Humanities	360	13.8
Foreign Language	134	2.8			
Elective for Credit	—	—	Electives for Credit	270	10.3
Physical Education	134	2.8	Physical Education	—	—
Military Training	—	—	Military Science	180	6.9
Total	4,848	100.00	Total	2,610	100.00

The single purposiveness of engineering training in the Soviet Union is reflected in the sequence of the vocational subjects directly related to the 'profile' of a given speciality. These specialized subjects take up 45 per cent of the scheduled time in the last three years of instruction. Another characteristic of Soviet trained engineers is reflected in the emphasis given to mathematics (388 hours in M.V.T.U.) *versus* (180 hours in M.I.T.).

10.4 *Teaching of basic sciences* like mathematics, physics, and chemistry has to be particularly mentioned. They are all oriented to the requirements of an engineer in general and to the speciality of the engineering branch in particular. For example, the following specific recommendations have been made in the teaching of physics in the Soviet Union :

(*a*) Higher education must assure for the future engineer not only the knowledge of modern industries and their technology, but *must also equip him with a knowhow of physics* (particularly of those branches which are nearest his speciality) *at such a level as will permit him to introduce into industry new, more progressive methods whenever they are ready for engineering application.*

(*b*) The teaching of physics should be a basic element of technical education and *not merely an element of general education.* That is why both the syllabi and the text-books must be tailored to the profile of a particular branch of engineering. Five or six text-books should be developed corresponding to the most important branches of engineering at the first degree level.

(*c*) The courses in physics and in technical thermodynamics should be coordinated to assure that these courses give a broad treatment of energetics, an understanding of free energy, the role of irreversible processes, and the place of atomic nuclear energy. Sufficient room should be provided within the general course in physics for those fields which are connected with the most progressive directions of technology, namely, radio, semiconductors, plastics, electronics, luminescence, and of course, the atomic nucleus.

10.5 *The stage at which narrow specialization has to start in engineering* : It is no doubt true that in highly technically developed countries, specialization is offered at the first degree stage. In those countries, boys grow up in an environment where they have a technical bias in their day-to-day living. Driving an automobile, talking of the performance of its parts, operating and repairing of electrical gadgets like a cooking range, heater, fan, etc. in their houses, working radio and television sets, etc. form part of their daily life. In the United States and the U.K., employment conditions are extremely easy. One can specialize in any branch of engineering and make a living. In the U.S.S.R., things are even easier. Jobs await the boys to finish their courses, In this country, boys do not grow in such a technical environment. It is therefore necessary that the first degree course should aim at creating this technical interest in the boy. Highly specialized jobs are very difficult to get. It is next to impossible to rely entirely for making a living by learning one particular narrow speciality in engineering. Jobs may have to be changed from one speciality to another. Taking all these factors into consideration, it is desirable to leave the present five-year integrated course in its present form. One almost revolutionary change has been suggested to keep in step with the present technological development that has taken place during these 18 years. That is, the very broad fields of civil, mechanical, electrical and other existing branches of engineering have been proposed to be broken up into many broad areas of study. This may be further reviewed 15 years hence, and in the circumstances existing then, the scheme of the courses may be further revised.

As a high degree of specialization is already there at the first degree level, in Western countries, post-graduate courses at the Master's level are looked upon more or less as a continuation of the Bachelor's degree. It is also looked upon as a training to take up research work. In many countries as in the U.S.S.R., there are no Master's courses at all. In other countries, research is only a partial requirement for the degree. In a course lasting for a year or two, the time spent on a research project can hardly exceed a few months. It cannot at any rate exceed 25 per cent of the total period of the course. During this period, it is too much to expect a student to do all the literature survey pertaining to the problem, then chalk out a programme of work do the analytical, and experiment parts of his investigations, process the data, and draw worthwise conclusions which will add knowledge to his subject of speciality. Most of the thesis done for partial fulfilment of a Master's degree is a farce. It may well not have been made. In some countries, research at the Master's level is a full-time course. This will no doubt enable the student to pick up the methodology of research. But then, the background knowledge of engineering the student possesses will be mostly that of the first degree level except in a *very narrow field of his speciality*.

10.6 At the first degree level, the student is expected to learn a number of basic facts in engineering and apply them mostly in the design and execution of projects. The second degree should not be construed as a continuation of the first degree level as has been done in most universities in the U.S.A. and a few other countries. The objective to be achieved is to increase depth in thinking, instead of gathering a wide range of information mostly in fundamentals in a variety of subjects as is done at the first degree level. This intensity in thinking is sought to be achieved in a variety of ways. The student is encouraged to study in only a limited field of knowledge. He is to discuss them in seminars, in discussion groups, and in oral examinations held by his guide at frequent intervals. He is to write papers of the review type as well as original contributions for publication. He may work out various alternatives in a design project and write a discussion as to why he thinks a particular project is better than others. The personality of the guide is a very important factor in shaping the mind of the student. He should encourage the student to think for himself, question critically the various topics he reads in his text-books, in technical journals, and at seminars which he attends. Actually, at post-graduate level, specially at the Ph.D. level, the master ('*guru*') transfers his own personality, stature, maturity in thinking, and originality of approach to a given problem to his students by close association. This training of the mind of the student can be achieved in two ways : (a) through working out critically a design and development project ; and (b) working intensively on an investigation problem in a very narrow field of speciality. These form the two distinct categories of post-graduate students. At present, this country is in need of design and development engineers, small-scale industrialists, management engineers, and consulting engineers in large numbers. These are to be trained in critical and intensive thinking through offering scope to show originality of approach in design and development projects, or in solving management 'cases'.

10.7 This country also wants research workers. It is better to start even from now in training only the best types in both the categories mentioned in the above paragraph. At the end of the course, those electing to specialize in research, should not only have made a substantial original contribution to the knowledge of the subject of their investigation but should also be capable of guiding others in research. The aim should therefore be to initiate only Ph.D. courses in research. This subject is further discussed in Chapter XII.

The students in the second category should be at the end of their course in a position to develop and design, either working individually, or in a team, entirely new equipment, or successfully copy and/or improve prototypes of equipment imported from abroad.

10.8 As mentioned in para 10.1, these post-graduate courses should be of two years duration, the first year being devoted mostly to learning the basic science and engineering subjects relevant to the narrow field of speciality. The second year should be devoted both to the studies necessary for preparing the design project and the preparation of the project itself. The project may be prepared in the college and/or in the factory engaged in a work allied to the speciality. The project should be defended before a Board of Examiners drawn partly from the colleges and partly from industry.

The curricula for the courses may follow largely the Russian pattern as indicated in para 10.3. As most of the basic subjects taught in a five-year course in Russia will also have been taught in our country, two years are more than enough to cover the subjects of narrow speciality not covered in our first degree course. Teaching of the basic science subjects like physics, mathematics and chemistry should be completely reoriented according to the Russian pattern suggested in para 10.4.

Instead of starting separate institutes for each speciality, we may act on the recommendations of the Robbins Committee, that post-graduate education should be developed mostly in few first-rate institutions. All the Higher Institutes of Technology (I.I.T.s) and the Regional Engineering Colleges should offer as many of the specialities as they can. Russia has listed more than 500 of them.

We may also act on another recommendation of the Robbins Committee that a few first-rate institutions should be developed whose main activity will be post-graduate work. They want 50 per cent of the student strength in post-graduate work. All the Higher Institutes of Technology (I.I.T.s) and other first-rate institutions should convert themselves into post-graduate institutions with at least 75 per cent of their students being devoted to post-graduate work. As the number of these first grade institutions to the total existing in the country (5 in 120) is very small, a percentage (75 per cent) higher than that (50 per cent) proposed by the Robbins Committee has been recommended. They should also train students for Ph.D., Dr. Eng., and other courses also.

CHAPTER XI

INDUSTRIALIST ENGINEERS : POST-GRADUATE AND GRADUATE COURSES

11.1 *Industrialist engineer* : In the present stage of development in our country, it is very necessary that all steps should be taken to encourage technical development. The starting of big industries requires considerable resources in men and money in addition to commanding influence in State and Central Governments. Their number is necessarily small and the contribution they make to national income though large does not very much benefit the common man. A more dangerous consequence of big industries being started by a few capitalists is the inhibition and retardation of the growth of technical knowledge in the country itself as this is imported from abroad. It is needless to state that foreign collaborators never disclose the details of their technical knowhow to local technical men. The tempo of the present rate of industrial development can be substantially raised if a *massive effort* is made to start small-scale industries all over the country both in urban and rural areas. One of the difficulties is the shortage of technical men who have the 'knowhow' of starting such industries. It is imperative that courses are opened to train such men, so that the importation of foreign technical knowhow is progressively reduced.

11.2 *Types of courses :* One type should be at the post-graduate level. Those who have a first degree in engineering or an equivalent qualification like the passing of sections A and B of the Associate Membership Examination of the Institution of Engineers (India) should be given a post-graduate degree course in Industrial Engineering extending over two years. The first year will be devoted to gaining all the knowledge necessary for running a small-scale industry, like production engineering, labour management and industrial psychology, economics and financing of business, cost accounting and budgetary control, materials purchase and handling, publicity, packaging and advertising, planning and layout of factory buildings, power supply and distribution, and such other allied subjects. The second year will be devoted entirely to the study of a narrow speciality in which business is to be started, for example, ferrous and non-ferrous foundry practice, precision optical instruments manufacture, manufacture of pressure gauges and control instruments, small horse-power motors, prestressed concrete beams, etc. The thesis for this course should consist of a complete project report for starting an industry in his speciality. This should be defended by a Board of Examiners. This is the M.E. degree course B in Chart 2.

The second type is a post-diploma course leading to the first degree in engineering. It can be of three and a half years in duration as in the case of other types of diploma students working for a degree. The first two years will be devoted to study of a narrow speciality manufacture which line interests the student. At the end of these two years, the boy will have grown in years so as to possess the maturity necessary for appreciating the subjects necessary for starting an industry. He should study the same subjects which are prescribed for the post-graduate students in this subject for one year. The last six months of the course should be devoted to the preparation of a thesis which should be a complete project for starting an industry in his speciality. This is the first degree course D in Chart 1.

11.3 The other highly specialized courses mentioned in Chapter V can also be offered both at graduate and post-graduate levels. To mention only a few, courses may be offered for designing and making surgical instruments for medical men. Similarly, for designing and making equipment required for sportsmen, exhibitors in international fairs, for installation in museums, cinemas and theatres, and for physically handicapped persons, other courses may be offered.

11.4 Essentially, modern scientific industries may be started in areas which are industrially backward. Technical institutions may be attached to them. The following is a typical list of industries which can be started in any part of the country : medicinal

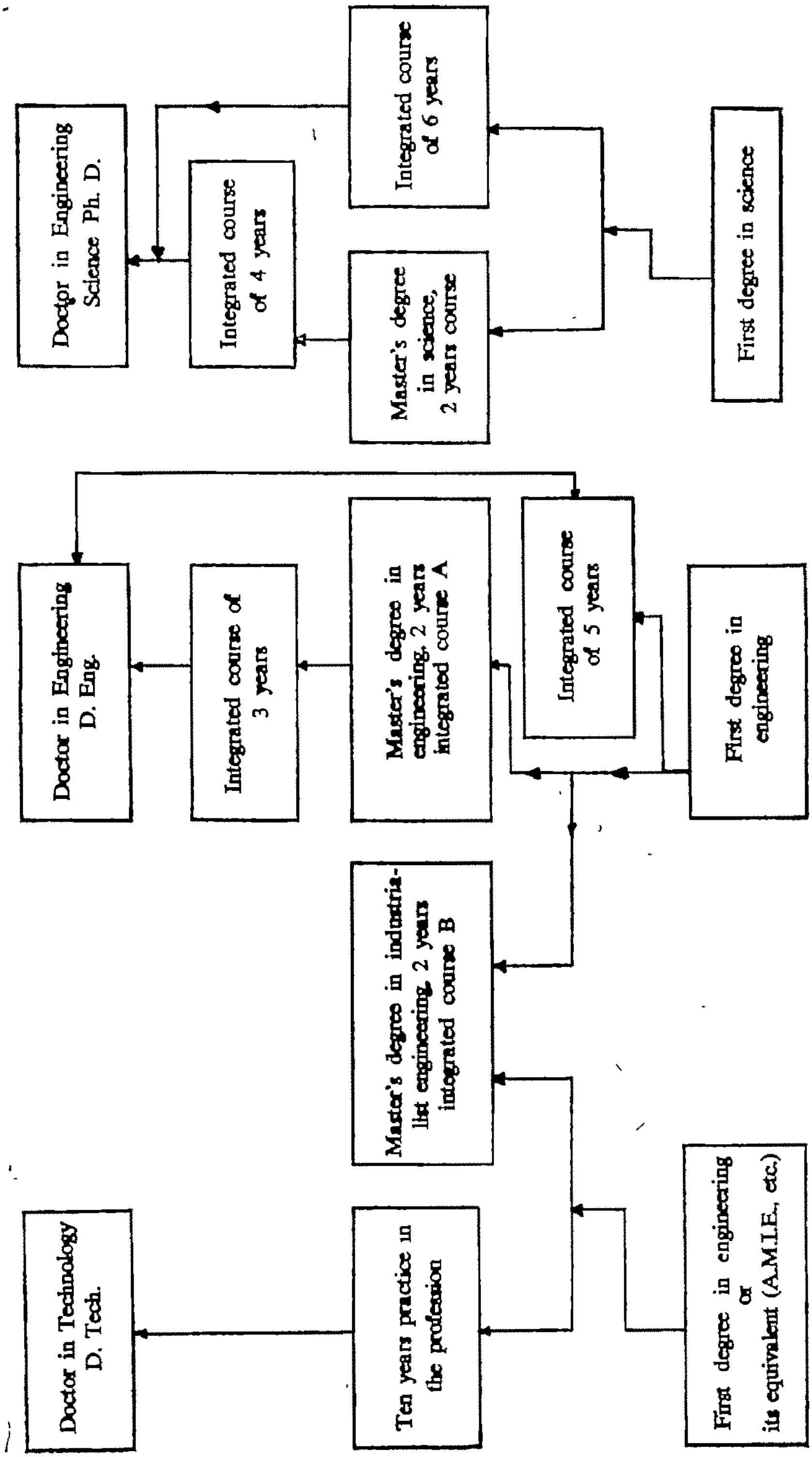
Doctor in Engineering Science Ph. D.
Integrated course of 4 years
Master's degree in science, 2 years course
Integrated course of 6 years
First degree in science
Doctor in Engineering D. Eng.
Integrated course of 3 years
Master's degree in engineering, 2 years integrated course A
Integrated course of 5 years
First degree in engineering
Master's degree in industrialist engineering, 2 years integrated course B
Doctor in Technology D. Tech.
Ten years practice in the profession
First degree in engineering or its equivalent (A.M.I.E., etc.)

CHART 2

products, glassware, optical equipment, radio and television sets, precision tools, fire extinguishers, electric light bulbs and fluorescent fittings, dental and surgical instruments, furniture, typewriters, typewriter ribbons and carbon-paper, musical instruments, washing machines, aircraft controls and components, paints and varnishes, nylons, vacuum flasks, rubber products, etc.

11.5 It is no doubt true there are no such courses anywhere in the world. That should be no reason why they should not be started in our country. These should be conducted both at the I.I.T.s and the Regional Engineering Colleges.

CHAPTER XII

ENGINEER-SCIENTISTS : RESEARCH COURSES AT DOCTORATE AND POST-GRADUATE LEVELS

12.1 For reasons already discussed, training of research workers should be at the highest levels. The aim should be to train persons who can not only do original work of a high order but are also capable of guiding others in research. These are the persons who can give a lead to technological development in one of the following ways : (a) by finding a new application to technological development by using the result of an investigation in the basic sciences (Ph.D. award may be given for this type of work) : (b) by making a substantial addition to our knowledge of engineering using the result of investigations made in the behaviour of engineering structures or their components under a specified field and/or laboratory conditions (D. Eng. award may be given for this type of work) ; and (c) or by making out an ingenious design of an equipment or a project based on years of experience in working in the field and/or laboratory (D. Tech. may be awarded for this type of work). Different dcctorate awards, denoting the stream through which the degree was obtained should be given. In this manner, it will be possible to secure a lead in technical development by all possible means.

12.2 The research course leads to the Ph.D. award and is meant to bridge the gap between pure and applied sciences. There are no special institutes of this type anywhere in the world except Russia and Germany. Even in those countries, the research institutes meant for this purpose start their training at the undergraduate level.

The following extract gives an idea of the practice followed in the U.S.S.R. 'Let us start the discussion of training research engineers by considering the work at the universities. As an example, an university has two faculties in physics, one dealing with pure physics as such, and another called mechano-mathematical faculty which bridges the gap between science and engineering. Both faculties have five-year programmes. The mechano-mathematical faculty is subdivided into three subdivisions : (1) mathematics, (2) astronomy and (3) mechanics. All the three divisions have the same programmes of study for the first three years. This programme is given below.[3] We see that there are not only courses of pure science in the fields of mathematics and physics, but also some courses of an applied nature, such as theory of vibrations and strength of materials. After three years of joint study, the courses of specialization begin and these are different for different divisions. For example, we shall consider the elective mechanics. They are (a) theoretical mechanics, (b) applied mechanics including theory of vibration, vibration of shafts, nonlinear vibration, theory of gyroscopes, gyroscopic stabilization, theory of governors, theory of models, kinematics of mechanisms and calculating machines, (c) wave mechanics, (d) theory of elasticity including advanced strength of materials, statics and dynamics of structures, theory of plates and shells, two-dimensional elasticity, variational methods of elasticity, stability of elastic systems, vibration of elastic systems, transition of non-linear waves, methods of measuring mechanical waves and photoelasticity, (e) theory of plasticity, and (f) aerodynamics and hydrodynamics'.

Research at doctorate level is conducted by institutes controlled by the Academy of Sciences. To quote from Timoshenko's book further, 'In Moscow, I visited two academic research institutes, the Institute of Mechanics and the Institute of Machine Engineering. The Institute of Mechanics has six divisions: (1) general mechanics, (2) aerodynamics, (3) hydrodynamics, (4) wave mechanics, (5) theory of elasticity and plasticity, and (6) theory of structures. The Institute of Machine Engineering is occupied with such subjects as kinematics and dynamics of mechanisms, strength of machine elements, and friction.

The number of instruction hours per week is as follows:

Name of course	Semesters									
	1	2	3	4	5	6	7	8	9	10
Analytical Geometry	6	5								
Calculus	8	8	7	4						
Higher Algebra	4	4								
Differential Equations	—	—	4	4						
Theoretical Mechanics	—	6	4	4	3	3				
Physics	—	—	5	4	5	2	2		Diploma work	
Differential Geometry	—	—	4							
Functions of Complex Variables	—	—	—	—	6					
Differential Equation of Physics	—	—	—	—	—	4	4			
Probability Theory	—	—	—	—	—	—	—	—	4	
Variational Calculus	—	—	—	—	2					
Hydromechanics	—	—	—	2	3	3				
Gas Dynamics	—	—	—	—	—	—	2	2		
Theory of Elasticity and Plasticity	—	—	—	—	—	3	3	—	—	—
Theory of Vibration	—	—	—	—	—	—	2			
Strength of Materials	—	—	—	3						
Astronomy, Descriptive	4									
History of Mechanics	—	—	—	—	—	—	—	—	4	
Marxism-Leninism	3	3	4	4						
Political Economy	—	—	—	—	2	2	2	3		
Dialectical Materialism	—	—	—	—	—	—	—	3	5	
Foreign Language	4	4	2	2						
Physical Training	2	2	2	2						

Considerable work for the Russian sputnik is said to have been done in this Institute. These institutes maintain close contact with industry. Recently, there was a conference dealing with mechanical problems dealing with steam turbine design. The papers presented at such conferences are published and distributed among the engineers of the corresponding fields of industry. Considerable effort is made to eliminate any gap between research workers and practical engineers and to select for research the topics most needed by industries.

The Academy of Sciences in the U.S.S.R. functions differently from similar institutions in other countries. Several research institutes some of which have a technical character are attached to the Academy. It was assumed that in this way the Academy would be well connected with the cultural and industrial life of the country and *would not represent only an isolated group of scientists.* In general, the idea of organizing scientific research institutes the staff of which can devote all their time to research work, and the idea of using the Academy as the organizing centre of the scientific life of the country seems to have found considerable success in Russia .

12.3 There can be no two opinions about the need of such research in our country. Starting undergraduate courses of an absolutely new pattern will throw out of gear the existing pattern of our education. This will merely create chaos without attaining our objective.

The University Grants Commission has rightly started advanced centres of research in several universities. Their functions can be easily enlarged as we have already a nucleus to start with. We can recruit graduates in science (B.Sc.) and offer them a six-year integrated course leading to a Ph.D. The first three years can be devoted to study of subjects similar to those studied both at the undergraduate and post-graduate levels in Russian universities and institutes which have faculties in the subjects which bridge the gap between science and engineering. The last two years should be devoted to research in one particular topic of interest either to the professor or to the student. The standard of Ph.D. can be the same as in the U.S.A., the thesis being only a partial requirement, emphasis being on intensive study of the subjects allied to the thesis. Unlike the Russian pattern, there should be a greater content of basic engineering in the course like engineering drawing and workshop practice and technology. Students who have completed a Master's degree in science can also take up this course, the duration being reduced to four years.

12.4 In science, we already have a few institutes devoted to particular fields of research like Sir C. V. Raman's Institute, the Tata Institute of Fundamental Research, and Ramanujam's Institute of Mathematics. It is desirable to build up, in course of time, a university devoted entirely to research in fields of pure science, in the common areas of science and technology, science and medicine, science and agriculture, and all other areas which bridge the gap between pure science and the professions based on the application of a knowledge of science.

12.5 The second stream is the one leading to the award of a D. Eng. degree. This can be an integrated course of five years for those taking their first degree in engineering. The first two years will be spent in studying the basic sciences, a foreign language, and a few engineering subjects. The last three years will be devoted to an intensive study of the subjects allied to the field of the students' investigations and the preparation of the thesis. A suitable curriculum for this integrated course has to be drawn up. For those who have a Master's degree in engineering, the course may be reduced to three years. The present M.E. courses are very well organized. There is no organized instruction for the D. Eng. course. This should be drawn up. The curriculum for this will have to be different from the curriculum in the integrated course of five years.

12.6 The third stream is the one leading to the award of D. Tech. (Doctor of Technology) degree. This corresponds to an external degree of a university like the London University. This is meant for those who have practised in the profession either as a teacher or as an executive for at least ten years and have gained a degree of maturity not generally found amongst the freshmen from the colleges. A few extraordinary persons manage to retain their academic interest alive and also exhibit great ingenuity either in design or project planning work. Such persons should be encouraged to make their contributions to the development of technology in the country. As this is an external degree thrown open to any person who has a first degree or its equivalent in engineering, great care is necessary in framing the scheme of examinations. The number of written papers for the examination has to be necessarily large. Each subject should have both a written paper and an oral examination. The standard expected of the thesis should be high and well defended before a duly constituted Board of Examiners. Study of a foreign language should be an essential requirement for this degree also.

12.7 All the Higher Institutes of Technology (I.I.T.s) and a few others of a similar standard should engage themselves in preparing students both for the Ph.D. and D. Eng. degrees. They should also conduct examinations for the D. Tech. degree. Selected professors should be recognized in the various Regional Engineering Colleges and other engineering colleges in the country for guiding candidates for the doctorate awards.

As will be recommended in the succeeding chapters, the control and expenses in the way of salaries, capital and working costs, etc. of the departments recognized for preparing candidates for the doctorate awards should be fully met by the Ministry of Education. These Education Ministry Professors and those working in the I.I.T.s may form an All-India Cadre of Professors available for transfer if necessary from one institution to another.

12.8 In the U.S.S.R., the Academy of Sciences plays a very large part in guiding post-graduate research. Many institutes are directly managed by them. Since education is a concurrent subject in our Constitution, unitary control is not feasible. It is also not necessary as there is no point in stifling academic freedom. What is however necessary is to ensure high standards, and uniformity of standards amongst all institutes and colleges as far as possible. The only national institution of science and technology which does not work in severe isolation from industry and general economic life of the people is the Institution of Engineers (India). Unlike the scientist, the engineer comes in daily contact with the people in his professional work. The Institution has on its Roll academic persons well known for their work and of the highest calibre, Directors of National Laboratories and others who are conversant with requirements of the type of research problems necessary for technical development in the country, eminent consulting engineers some of whom are of international repute, industrialists who know all about requirements of industry and the associated problems, specially those of the technical 'knowhow', they are getting from their foreign collaborators, and many others. This Institution is the obvious choice for being entrusted with the responsibility of maintaining standards, drawing up periodically lists of areas in which research is necessary, and in ensuring fair and impartial recruitment of technical staff. It should be legally made obligatory to associate one or more representatives of the Institution at all oral and written examinations for the doctorate degree, and in selection committees for the recruitment of Professors and other staff members who are to guide research for doctorate awards.

Appendix

Paper 14. 'Planning of Technical Education at the Post-graduate Level' by Dr. S. K. Sen.

Paper 15. 'Development of Electrical Engineering Education in India During 1966-81' by Prof. H. N. Ramachandra Rao.

CHAPTER XIII

MANAGEMENT ENGINEERS AND PROJECT CONSULTANTS : POST-GRADUATE COURSE

13.1 *Management engineer* : Management engineers are the persons who have a knowledge of both technology and management. The post-graduate course in this respect is not meant for engineering graduates fresh from colleges. A certain amount of maturity is necessary for getting the full benefit of this course, coupled with actual experience in supervisory positions. Admission to the course should be limited to those who have at least a minimum of ten years experience in the profession. The course can be of two years duration, one year being devoted to study of relevant subjects like principles of planning and layout of projects including preparation of project reports, industrial psychology, industrial economics, operational analysis, statistical quality control, cost accounting, labour management, and other allied subjects. The second year should be devoted entirely to the preparation of a project report of the same project in which the person is working with a detailed analysis of how he proposes to increase its efficiency in factors which are material for starting and working a project and selling its end products like capital formation, financing, materials purchase, stores, labour organization, wages, machines, their layout and installation, etc.

13.2 The following remarks taken from the Robbins Report. are pertinent to this subject. 'Education for management as such, however, is a subject of considerable perplexity, and opinion is divided on what methods of training are appropriate. Many of our witnesses have complained that the present arrangements for management education are deficient. This country, it is urged, does not provide the training for management that is needed if it is to hold its own in the modern age. Education in individual

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[1] 'Higher Education'. Report by Lord Robbins' Committee. Her Majesty's Stationery Office London, 1963-64

techniques is provided at the undergraduate level, but this is not specifically directed to management. At the post-graduate level, where education of this sort should be chiefly at home, there is nothing comparable to the great business schools of the U.S.A. *The problems of devising courses are often underestimated.* In the first place, it is impossible to devise any course of education or training that can automatically and correctly select future managers ; *and it is difficult to devise one for those who have had no experience in industry or commerce.* The most appropriate time for many students to take a course is when they have already begun to establish themselves in careers'.

'These courses should be offered only in large schools or institutions founded for this purpose. They should be associated with a well established technical institute or a university campus. They should be situated in the neighbourhood of large business centres. Continuous contact is best maintained through close proximity, and such educational enterprises can only be properly staffed if they have recourse to a good deal of part-time assistance. Schools of management are likely to gain by the employment of those who have been successful in their professional careers'.

13.3 There are already well-established Institutes of Management in this country. There is necessity to open new institutes. The present trend in thinking is that this subject is best taught in a separate institute, instead of in a department attached to a college as sometimes proposed.

CHAPTER XIV

PRACTICAL TRAINING AND APPRENTICE TRAINING

14.1 This work of apprentice training does not come strictly under the purview of the Ministry of Education. But then, this is one of the most important activities necessary for rapid development of technology and increase of productivity in the country. This activity requires to be increased manyfold by the Ministry of Labour. Broadly, apprentice training can be of four categories.

14.2 *Apprentice training for the uneducated* or those who have just completed the first four years of compulsory education : At present this type of apprentice, mostly in the villages or towns, gets attached to a senior workman. He picks up the craft of his senior from working alongside. The skilled man is mostly concerned to earn as much as he can, so that the amount learnt and the degree of skill acquired by the apprentice depends on the chance that his senior has a sympathetic understanding of his problems and not his own natural aptitude to 'pick up the trade'. This system requires to be reorganized. These boys should be given suitable scholarships. Craft inspectors should be appointed to go and inspect the progress of these apprentices and incidentally initiate the senior workmen to the use of modern tools. Suitable legislation is also necessary to compel these boys to attend special schools for a few hours in the evenings at least two days in the week when they can be taught the rudiments of general education. They should also be given some nourishment when they attend these evening schools. The duration of these apprenticeships may be for three years after which an examination for a Junior Skilled Workmen's National Certificate in a particular trade may be issued. There may be further Senior and Proficiency grades in these examinations, these being taken after intervals of two years each.

14.3 *Crafts apprentice*: This type of apprenticeship may be for those who have completed seven years of school education. They may learn a particular craft like fitter, turner, machinist, patternmaker, moulder, toolmaker, millwright, instrument maker, electrician, sheetmetal worker, and so on, in apprentice schools attached to factories. Concurrently with the training received in these schools, the apprentice should follow a course in elementary mathematics, drawing and proficiency in writing and reading in his own language. The course may last for three years for the Junior Grade Craftsman's National Certificate. There may be further Senior and Proficiency grades at intervals of two years each, when he can learn more of drawing, mathematics, and study text-books pertaining to his craft. The course has to be under the general supervision of qualified craft inspectors appointed by the Central or State Governments. Generous scholarships should be given to the boys by the Government, the cost of running the schools being borne by the factory management. Such schools have already been established in many factories by legislation. Many more have to be established.

14.4 *Engineering apprentices*: This apprenticeship is meant for those who are employed in factories after passing the X standard or the S.S.L.C. Examination. After the completion of their training in the factory, these students should be capable of working as assistants either in the drawing office or in the design and development section, or go out as salesmen of the products of the company. A course lasting for three years should be started for this purpose. It is important that these apprentices obtain a reasonable skill and knowledge of a wide range of crafts, through spending periods of from one to four months working in each of the following trades: fitting, erecting, machine shop, pattern shop, foundry and forge, and during the last six to twelve months in the drawing office. If the apprentice is meant to be absorbed on the sales side, he should spend a further six months in the cost accounting office. The course should include theoretical instruction to enable these boys to appear for the Studentship Examination of the Institution of Engineers (India) which is of the same standard as the first-year B.Sc. course. Thus a way is paved for them to become full-fledged engineers in course of time by passing Sections A and B of the Associate Membership Examination of the Institution of Engineers (India). Generous scholarships should be given by the Governments at the Centre and the States for these apprentices. Suitable government grants-in-aid should be given to meet the cost of giving actual tuition by the factory management. Craft inspectors should supervise this training.

14.5 *Graduate practical training*: This is meant for those who have just passed out of the college. The object of this training is for the student to gain a knowledge of the potentialities of processes and skills rather than to acquire the skills himself. His educational background is such that he should aspire to occupy any position of a technical or managerial nature. It is during this period that he should develop his personality and character to be able to command the respect of the workmen, his colleagues, and his superiors. The training should be more or less similar to those given for engineering apprentices, covering practically all the departments in the factory. The duration of training should be 12 months. Legislation should be made making it compulsory for every fresh graduate to register himself in an employment exchange before he can get employment either in the public or private sector. His name for employment should be suggested only after the graduate has satisfactorily completed his training. The training has to be under the supervision of a craft inspector appointed by the Central Government. The graduate apprentice will be expected to submit a full report on the work he did during his training and pass an oral examination before a Board of Examiners consisting of a representative from the factory in which he has taken the training, the craft inspector or his nominee, and a person unconnected with both, preferably a nominee of an organization like the Institution of Engineers (India) at its Local Centre. Graduates should be given generous scholarships by the agency who are to employ them. He should first be recruited through the employment exchange but should not be allowed legally to start their career unless and until he has satisfactorily completed his practical training.

This training is unnecessary for those who wish to work for a post-graduate course. They too will have to undergo practical training before they are employed. The duration of the training, and the curriculum to be followed have to be decided separately for each course. In many cases, they may be exempted from taking such training altogether.

Appendix

Paper 1. 'Suggestions for Better Technical Education in India' by Dr. A. K. Chatterjee and Prof. B. S. Rao.

Paper 7. 'The Crisis in Engineering Education' by B. Seshadri, paras 53-69.

Paper 16. 'Training Facilities in National Small-Scale Industries Corporation Ltd.' by Shankar Dass.

CHAPTER XV

TRAINING FOR TECHNICAL MEN IN EMPLOYMENT

15.1 Opportunities should be given to everyone employed in some technical activity or other, howsoever humble it may be, to rise to the highest position if the person has the necessary determination, capacity and perseverance. For those in employment, the following are generally the ways offered for this purpose.

(a) Part-time or day-release courses with release from the factory for one or two days in a week in addition to Sunday.

(b) Sandwich courses.

(c) Evening courses.

(d) Correspondence courses.

All the four types of courses may be offered at all levels of technical education, starting from the craftsman's course to the doctorate courses.

15.2 *Part-time or day-release courses, U.K. practice :* These courses are very successful in the U.K.[1] From about 1939 to 1955-56, part-time day education had expanded *seven-fold.* The following table gives an idea of the popularity of this type in 1955-56.

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[1] 'Technical Education' by P F.R. Venables. *G. Bell & Sons, Ltd.*, 1956.

Subject	Total number	Percentage to the total
Agriculture and horticulture	928	0.30
Mining and quarrying	29,691	9.50
Treatment of non-metalliferous mining products other than coal	1,306	0.44
Chemical and allied trades	10,995	3.55
Metal manufacture	3,685	1.19
Engineering, shipbuilding and electrical goods	115,318	37.25
Vehicles	5,063	1.63
Metal goods not elsewhere specified	594	0.10
Precision instruments, jewellery, etc.	698	0.22
Textiles	5,301	1.71
Leather, leather goods and clothing	3,058	0.99
Food, drink and tobacco	6,877	2.22
Manufacture of wood and cork	1,658	0.53
Paper and printing	10,477	3.38
Other manufacturing industries	2,614	0.84
Binding and contracting	39,195	12.66
Gas, electricity and water	5,539	1.79
Transport and communication	11,162	3.60
Distributive trades	10,515	3.39
Insurance, banking and finance	160	0.05
Public administration and defence	16,481	5.32
Professional services	25,351	8.19
Miscellaneous services	2,885	0.93
Total	309,255	100.00

Out of the 15 different categories, the first six biggest proportions (in decreasing order) come from engineering industries, building, public utilities and local government, chemical industries, and commercial and professional occupations.

These are provided for three main levels leading to professional, technical and skilled craftsmen level and up to seven or more years of professional qualifications.

Students are regularly trained for (a) the final B.Sc. London University external degree in engineering—this takes eight years generally after Matriculation; (b) the National Certificate course—this takes six years after Matriculation; and (c) a craft course leading to the City and Guilds of London Institute Certificate—this takes five years.

The duration depends on the time available in the college. One course is to have one and a half day's release plus one or two evenings or two evenings plus Saturday morning. At Rugby, the degree course is arranged in close cooperation with British-Thomson Houston Co., Ltd., on the basis of one day and two evening over a period of two years and two terms for Part I and full-time attendance for four terms for Part II of the London University B.Sc. degree. The course is the 'industry-based' equivalent of a full-time university course. Sometimes an alternative mode of attendance is continuous attendance 'for one continuous period of eight weeks or two continuous periods of four weeks every year'.

In the present stage of development of this country, such courses may not be practical for persons employed in factories. The position can be reviewed five years later when more factories both in numbers and size will have come into existence.

15.3 *Sandwich courses -or cooperative courses* :[1] 'They are so called because 'layers' of full-time college study and industrial experience alternate over a period of years, for example, six months in industry succeeding six months in college and so on turn about for three or four years. The American name is 'Cooperative Courses', because they can be run only by the closest cooperation between college and industry'. The purpose of these courses as set out by Committee of the American Society for Engineering Education are: (a) To impart first-hand an actual knowledge of, and familiarity and experience with the execution in industry, of engineering designs, projects and developments; (b) To impart an understanding of and familiarity with the problems and viewpoints of working men and women; (c) To assist students, by direct and personal experience in industry, to test their aptitude for engineering courses; (d) To enable engineering students to adjust themselves to engineering employments by gradual and easy transition from academic pursuits and mode of life to the requirements of industry; and (e) To prepare students for the administrative and operative functions which, to a greater or lesser degree, enter into most engineering careers.

'Just as laboratory periods in the training of the pure scientists, and the clinical experience of the medical students in walking the wards, so the experience in industry fulfils an essential need for the engineer *within the overall period of training* and not in some post-dated period'. The vacation works experience now increasingly arranged for university students is a belated token of this need. The other advantages of a sandwich course stated in the U.S.A., and considered most relevant to the U.K., are: (f) The student works in some of the most modernly equipped manufacturing plants and laboratories in industry. These are on a scale and standard *utterly beyond the resources* of any teaching institution, which is also spared acute problems of obsolescence, (g) During the several works' periods, the firm has a first-hand opportunity of observing the student's abilities and capacity for development, a form of selection by training which is probably more profitable than the usual summary or even extended interviews plus the college record on paper; and (h) The student must learn to work with all kinds of people and to follow instructions under industrial conditions, and become acquainted with job practices, skills, labour and plant operation before rather than after graduation.

With all the foregoing points in favour of these courses, they have not become popular. 'The scheme involves administrative difficulties on both sides which, whilst not insuperable, may do much to affect whatever benefits the scheme may provide.'[2] 'Another practical argument of consequence is that it is very difficult, if not impossible, to relate the college studies with the work of the students in a large number of firms and an even greater diversity of occupations and jobs within those firms. The counter-argument is that this betrays a confusion of thought about college studies, for these are not to deal with the specific industrial practices of the individual firms, but with the principles underlying them. The more the student sees these underlying principles being applied in practice, the better it is for both his theory and practice. Another academic argument is that the operation of economic and other non-scientific factors may prevent the student gaining a fully scientific insight into the problems involved. Again the argument is misconceived, for the mode of training is not for scientists but technologists for whom an understanding of the operation of these non-scientific factors is of vital importance, and that nowhere can the student under expert guidance gain as real an understanding of them as in industry itself.'[1]

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[1] 'Technical Education' by P.F.R. Venables. *G. Bell & Sons, Ltd.*, 1956.

[2] 'Universities and Industry'. Anglo-American Productivity Report, 1951.

'The structure of the industry may have a critical effect on the administration of the course in deciding whether it shall be a 'college-based' or a 'works-based' course. In the former, the students are enrolled by the college and placed in industry for the works periods ; in the latter, the students first of all enter industry and are then seconded or released by their employers to attend college. In America, the schemes are preponderantly 'college-based.'[1] The advantage claimed for this method is that the student remains primarily a student in training, and not a full-time employee or operative subject to the full force of industrial problems. In the U.K., the more general 'works based' pattern may be due to the more closely knit industrial conurbation and shorter travelling distances.'

These courses of both types have come to stay and are becoming increasingly popular. One of the factors very greatly influencing this increase in popularity is the opportunity it affords to employees to qualify themselves to membership of professional institutions, or certificates or diplomas of Technical Boards.

15.4 In our country also, both the 'college-based' and the 'industry-based' types of sandwich should be encouraged. The Industrial Training Institutes should train students from the factories for the National Craftsman Certificate examinations. The polytechnics should train students for the State Board Diploma examinations. Engineering colleges should start such sandwich courses to train duly qualified employees to sit for the examinations of professional bodies like the Institution of Engineers (India). Private enterprise should be encouraged by giving generous grants to start courses to train employees of factories according to a well-planned sandwich system for recognized certificate, diploma and professional membership examinations. These courses can be run all the 12 months in a year in such institutions in cooperation with the neighbouring factories.

All efforts in the private sector should be encouraged to open institutes to train students through 'sandwich' courses for varying types of conferments at craftsmen, diploma and professional membership examination levels. The present practice prevalent in many universities of recognizing institutes, or colleges ill-equipped with teaching personnel, buildings and equipment should be severely discouraged. The factory training the students will receive in their sandwich courses will go a long way to make up for deficiencies in equipment in their own institutes or colleges. The 'thickness of the sandwich', that is, the distribution of the time between academic and factory work, should be a matter of convenience to both the parties. The duration of the courses should be sufficient to pass the prescribed examinations.

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[1] Technical Education' by P.F.R Venables. *G. Bell & Sons, Ltd.*, 1956.

The success of these courses, to a considerable extent, depends on the size and nature of the firms who show interest in giving such training to their employees. During the period of work in the colleges, the employees may probably have to be paid just a stipend instead of their usual salaries.

15.5 *Evening classes :* These are the oldest form of further education in technology for those in employment. Evening classes are not as popular as they ought to be. The thinness of attendance at these courses may be due to any of the following causes : overtime and being away on a job ; shift work ; an indifferent or apathetics firm which will not allow time to get to a class on time ; travelling difficulties specially in bad weather ; ill-health (personal and in the family in case of married students) ; and changing from one job to another. There are also the counter-attractions of movies and the clubs. The problem is not merely to list these difficulties but how to overcome them. Most of these evening classes are held between 6.30 to 9 p.m. Generally, they consist of one lecture followed by one and a half hours of practicals or tutorials. The range of standard of courses available is very great, reaching from very elementary courses in general education and technical skills up to final professional examinations and beyond to post-graduate or post-advanced refresher and intensive courses, and even research.

It is very desirable to encourage these classes at all levels. The Higher Secondary Technical Schools and the Industrial Training Institutes should make arrangements to hold evening classes in trades. The polytechnics can hold classes to coach students for National Diplomas, or diplomas awarded by the State Boards of Technical Education. The engineering colleges and a few well equipped polytechnics may also start evening classes for coaching students for the Associate Membership Examination of the Institution of Engineers (India). Private enterprise running colleges on their own can also start such evening classes as they do not involve any large outlay in workshop equipment and laboratories as the students will already be in professional employment.

15.6 *Correspondence courses :* In Chapter IX, a list has been furnished of the correspondence courses offered in the U.S.S.R. in technology. This reflects a conscious effort to increase the rate of training technical personnel to a higher level of competency without diminishing the current contribution of the technical manpower in the country. The following table gives an idea of the rate of expansion.

Type of instruction	1950, thousands	1955, thousands	Per cent of 1950
Resident full-time	278.3	450.6	162
Resident evening course	2.4	100.0	4,167
Correspondence	40.7	100.0	246
	321.4	650.0	202

The proportion of students studying engineering by correspondence or in evening schools while holding full-time jobs (on six-day week basis, eight hours per day) has definitely increased. In 1955-56, this category of evening and correspondence course students accounted for 30 per cent of the total enrolled in engineering courses, as against a mere 14 per cent in 1950.

In India, hardly any attempt has been made to popularise correspondence courses in engineering. There are very few such courses. The Ministry of Education should encourage the various Regional Engineering Colleges to open correspondence courses in engineering both at degree and diploma levels. The college should also coach students for professional examinations like the Associate Membership Examination of the Institution of Engineers (India). Such other colleges who are willing to take up this work should also be encouraged by generous grants. Such courses should be for a period of 10 months at a stretch. At the end of every 10 months, students should attend laboratory, workshop and drawing classes, and lectures for 60 days in a year. Retired teachers and retired professional engineers can be very usefully associated in this scheme.

Appendix

Paper 1. 'Suggestions for Better Technical Education in India' by Dr. A. K. Chatterjee and Prof. B. S. Rao.

Paper 17. 'Opportunities for Pursuing Higher Education' by P. B. Katakkar.

Paper 18. 'Technical Correspondence Courses in the U.S.S.R.'

CHAPTER XVI

TECHNICAL EDUCATION FOR WOMEN

16.1 *Recommended practice in the U.K.* : The following extract from the Robbin's Report[1] gives a line of thinking on this subject. 'It is particularly important that courses should be available for married women. Before the war, three-quarters of the women in employment were unmarried. Many more married women go out to work (over a third now, compared with a quarter in 1951 and a tenth in 1921). At the same time, the age of marriage has fallen and the expectation of working life has lengthened. As a result, a new career pattern has emerged, a short period of work before marriage and a second period of work starting perhaps 15 years later and continuing for 20 years or more ; and the indications are that this pattern will become increasingly common. The prospect of early marriage leads girls capable of work in the professions to leave school before they have entered the sixth form, and even after sixth form studies, too many girls go straight into employment instead of into higher education. When their family responsibilities have lessened, many of them will desire opportunities for higher education. And many, if not most, married women who have already enjoyed higher education will need refresher courses before they can return effectively to professional employment. This will be partly true for doctors, for teachers and for social workers, but there will also be a need in other fields such as commerce and languages. There is here a considerable reserve of unused ability, which must be mobilized if critical shortages in many professions are to be met. Such courses should be organized in existing institutions and wide publicity given to them.'

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[1] 'Higher Education.' Report by Lord Robbin's Committee. Her Majesty's Stationery Office, London, 1963-64.

16.2 *Prospects in India* : Here also such courses should be organized and the vast women-power in the country should be made use of for developing technical activities.

CHAPTER XVII

TECHNICAL EDUCATION—EXTENSION WORK TO IMPART KNOWLEDGE OF LATEST DEVELOPMENTS TO PERSONNEL IN EMPLOYMENT

17.1 As the pace of discovery quickens, it will become increasingly important for practitioners in many fields to take courses at intervals to bring them up-to-date in their subjects. A wide variety of courses should be offered at all levels.

17.2 *At the craftsman level*: The Higher Secondary Technical Schools (now called Industrial Training Institutes or Junior Technical Schools) should be the centres where short courses should be held to teach operation of new types of machines and tools. Recent advances in the technology of trades like carpentry, welding, use of modern materials in building industry, etc. should also be taught in such short courses.

The duration of these courses need not exceed four weeks at a time ; and normally it can be of two weeks.

In addition, short films should be prepared explaining the proper use of machines in current use or new ones.

Technical brochures full of illustrations and photographs should also be prepared for distributon. Each brochure may pertain to a particular machine or equipment and need not exceed about 20 pages.

17.3 *At post-diploma level*: The polytechnics should be the centres for organising such short-term refresher courses.

As in the case of craftsmen courses, refresher courses should be confined to very narrow fields of technology like tools used in a fitter's shop or a carpenter's shop, modern methods of lighting a factory building, building a radio set, precasting of reinforced and prestressed concrete beams, etc.

Similar types of films and brochures prepared for the use of craftsmen should also be available to the diploma holders. In addition, courses may be organized on subjects pertaining to a foreman's work—like increasing productivity amongst workmen, ensuring better safety in the factories, better control in the use of materials used in the manufacture of an equipment, etc.

The duration of these refresher courses should not exceed four weeks at a time ; normally, two weeks should be sufficient.

There are no technical journals published to cater primarily for the needs of the diploma holders. The Government at the Centre, should subsidize, at least in the early stages, the publication of a journal in the State languages, in English, and in Hindi.

In addition to publication of a journal, every encouragement should be given for holding seminars. The duration of seminars may be seven days and they may be organized in groups. All the time should be spent in presentation of working papers by members of the group in turn and discussing amongst themselves.

The diploma holders should also be encouraged to join the Institution of Engineers (India) as Students. The admission fees and the annual subscription for a number of bright boys may be paid by the Central and State Governments. These Students can attend lectures held at the Institution premises, read the journal, and make use of the library facilities. They can also organize lectures and seminars amongst themselves. This is being done in a small way at many of the Institution's Local and Sub-Centres. These activities require to be enlarged manyfold.

The Central Government and the State Government should finance the Local and Sub-Centres of the Institution of Engineers (India) to purchase books for their libraries which will be of interest particularly to diploma holders.

17.4 *At the post-first degree level*: The engineering colleges, the Higher Institutes of Technology, and professional bodies like the Institution of Engineers (India) can all be centres of activity for imparting knowledge of the latest developments and techniques in science and technology to those in employment. The following methods may be adopted:

(a) *Refresher courses*: These can be of two types. In one type, the course pertains to the learning of a new method or latest methods of design, or technique in the manufacture, erection or operation of a particular product or equipment or a structure. For example, there can be a refresher course in designing brakes and dynamometers of various types and capacities suitable for a variety of machines, or design of earth dams, or design of gates and sluices in a hydroelectric project, and so on. The course is strictly limited to a very narrow field of speciality.

In the second type, the refresher course is meant to make a survey of the developments in a particular technology during the last 10 years or some such period.

(b) *Symposia*: A particular subject of study is chosen. Papers are invited on the subject and a discussion takes place on the subject. For example, 'Technical Education' can form a subject for a symposium.

(c) *Seminars*: These can be held in the same manner as for post-diploma students.

(d) *By joining professional institutions like the Institution of Engineers (India)*: This will enable them to use the libraries at the Local and Sub-Centres of the Institution, attend technical lectures, and also obtain its technical journals. They can also come in contact with other co-workers in their field and learn by mutual discussions.

17.5 *At post-doctoral level*: The Higher Institutes of Technology and professional Institutions like the Institution of Engineers (India) should be entrusted with the responsibility of conducting the same types of courses, like refresher courses, seminars and symposia. In these, the scope of the subjects are narrowed down even more than at the post-first degree level. These should be held on an 'invitation basis', and should be open only to those invited to attend them. Experts from abroad should also be invited where necessary. At the end of each of these courses, the proceedings should be published.

17.6 *Deputations abroad :* Another useful method is to depute persons both in and outside India. The deputation abroad may be for the following purposes :

(a) *At post-craftsmen level and post-diploma level :* Crafts teachers, foremen in factories and others (i) to actually work in factories or in institutes where their trade is being practised ; (ii) to visit trade fairs, firms and international exhibitions and firms where they sell different types of equipment pertaining to their trade ; and (iii) to also visit apprentice schools or trade schools where their trades are being taught.

(b) *At the post-first degree level :* These should be deputed to visit actual works or factories under erection or in operation. Special efforts should be made to send industrialist engineers abroad. One of the essential conditions should be that they should be actually engaged as proprietors of an industry by themselves, or should have worked in a small-scale industry for a minimum period of three years before they are sent abroad. They should be sent in large numbers to visit international fairs, exhibitions, and also factories manufacturing similar products.

(c) *At post-doctoral level :* Teachers, design engineers employed in design offices either in public or private sectors, and other research workers should be encouraged to write papers for international conferences or publish them in journals of repute in India. They should be encouraged to attend international conferences only if they fulfil both these conditions : firstly, they should have continually kept contact with technical developments by being members of a professional society in India, and secondly, their paper should have been accepted by the conference which they are attending. Mention has been made of their attachment to a professional society in India with the deliberate intention of ensuring that national consciousness is developed in these people. They should look forward to supporting and raising the standards of the technical output of these societies rather than lend their support to professional bodies abroad.

The duration of these deputations at all levels need not exceed three months at a time.

17.7 *Deputations in the country :* Teachers, design engineers and research workers should be sent to work under actual factory or field conditions occasionally. Those working in factories should work in research and teaching institutions for short period. The minimum period should be at least six months. They should be attached to any one project or institution so that they can concentrate all their attention on it instead of frittering away their energies in visiting numerous projects.

17.8 For the success of these schemes, four conditions are essential : (a) Financial support from Central and State Governments for organising refresher courses, seminars and strengthening libraries in professional institutions at Local and Sub-Centres, and starting technical journals for technicians and craftsmen ; (b) Financial support both from Central and State Governments and industries to depute qualified persons to attend international fairs, exhibitions, conferences and even factories and projects ; (c) Cooperation from the employers both in the private and public sectors in releasing their personnel to attend these ; and (d) Creating awareness amongst technical personnel at all levels, specially at the post-draftsman and the post-diploma levels of the opportunities that exist to improve their knowledge and prospects. This should be done by all well known methods of publicity.

17.9 *Study of advanced technology abroad :* There are any number of areas of knowledge in which our country is lagging behind. In the years to come, with the present rate of advance in knowledge, these areas will increase both in width and depth. Only an expert body which can keep continually in touch with the progress going on all over the world will be able to demarcate these areas of study. Such a body should not consist of only eminent experts. The National Institute of Sciences, for example, by its very constitution works in complete isolation from industry, as its membership is confined only to the very best men in the sciences. It is not therefore reasonable to expect such a body to mark out areas of research which are of immediate need for the industrial development of the country.

The Institution of Engineers (India) has a more broad-based constitution and has expert engineers, scientists as well as industrialists and others in the country as its members. It is therefore better suited to be entrusted with the work of periodically marking out the areas of study for which persons have to be sent abroad, fix the qualifications of the persons to be so deputed, the places and the duration of their studies, and such other details. For the selection of such personnel, selection committees may be constituted consisting of an academic expert, a top industrialist engineer, and a representative of the Ministry of Education. Such a mode of selection will be free from political and other pressures which often hamper fair and impartial selection.

Appendix

Paper 4. Consensus of 'Seminar on Technical Education in India and Its Development (1966-81)' held by the Bengal Centre.

Paper 19. 'Imparting Knowledge of Latest Developments and Techniques to Technical Personnel Employed at Different Levels' by G. C. Mathur.

Paper 20. 'Methods of Imparting Knowledge of Latest Developments and Techniques in Science and Technology to Those in Employment' by Prof. R. N. Banerjee.

CHAPTER XVIII

TECHNICAL EDUCATION FOR THE PHYSICALLY HANDICAPPED

No comments.

CHAPTER XIX

TECHNICAL EDUCATION AND MILITARY REQUIREMENTS

19.1 For obvious reasons, no attention was paid to development of technical education as an aid to strengthening defence till the country attained independence.

A considerable amount of expansion since 1951 has taken place in training personnel with technical education for military requirements. The number of schools and colleges for this purpose are still very few compared with the requirements of a vast country like India.

19.2 *Practice in the U.S.S.R.*:[1] The Soviet Union also maintains military schools for training in engineering and applied science at advanced levels. These schools are not regularly mentioned in the Soviet handbooks and journals on higher education but even the occasional references in newspapers makes it unmistakably clear that military schools of engineering occupy an extremely important and highly privileged place in the total Soviet plan for selecting and training the technical specialists needed to advance its efforts towards superiority in the weapons race and in technology generally. It should be noted that military schools of higher technical education have a long history in Russia. Many of the outstanding scientists and mathematicians of pre-revolutionary Russia were educated in military schools. The following is an incomplete list of military schools in Russia: (i) Academy of Armoured Tank and Mechanized Troops, (ii) Academy of Artillery Sciences, (iii) Armament Industrial Academy, (iv) Higher Engineering School of Construction, (v) Leningrad Military Air Academy, (vi) Military Academy of Chemical Defence, (vii) Military Artillery Academy, (viii) Military Air Engineering Academy; (ix) Military Electrotechnical Academy of Communications, (x) Military Engineering Red Banner Academy, (xi) Military Medical Academy, (xii) Military Academy of Administrative Services and Supply, (xiii) Academy of Shipbuilding and Armaments, and (xiv) Riga Military Air Engineering Institute.

These institutes have graduate four to five-year courses, in addition to post-graduate courses.

19.3 In this country also, such full-fledged technological institutes of training, research and development should be established. Boys fresh from Higher Secondary Technical Schools or Higher Secondary Schools should be recruited. They should be given five-year integrated courses leading to a first degree in technology. The courses should in the final year lead to a high degree of specialization in a narrow field of technology which is essential to defence requirements, that is, there should be an elective in the final year of the course. Those who are fit should then be recruited as Lieutenants in the Army or equivalent posts in the other services. After the necessary military training, they should be posted back to the institutes to undergo post-graduate training for two years in a still narrower speciality either in engineering or applied science. These post-graduate courses should be of two types, one specializing in design for technical development, and another specializing in a narrow field in the basic sciences (physics or mathematics mostly) to fit them for research and development work of more sophisticated types. Those who successfully complete this training should be given a few advance increments or an extra allowance and posted to field service for a year or two. They may again be re-posted to the institutes to work either as a staff member, research fellow for a doctorate, or a designer in the technical development section. In this way, the Defence Services will have technical men highly qualified in technology with experience in military service. These persons will be competent to hold positions of management and direction in military technical institutes.

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[1] 'Soviet Education for Science and Technology' by Alexander G Korol. *John Wiley & Sons, Inc.*, 1957.

The present technical colleges at Kirkee, Bangalore, Hyderabad and other places should all be converted along with the Defence Science Laboratories to full-fledged Military Technological Institutes of teaching, research and development, each specializing in a narrow field of technology. For example, there are four military establishments at Bangalore, one connected with the air force, one with research and development in telecommunications, another in aircraft design, and the fourth in gas turbines. Each of them should be converted into a full-fledged institute of teaching, research and development at all levels starting from a five-year integrated course for a first degree in engineering or technology to the doctoral level. Thus, there should be four Military Technological Institutes in Bangalore.

19.4 The management of these higher institutes, which will probably be more than 30 in number to begin with, has to be vested in an Executive Board like Railway Board consisting of experts well known for their knowledge of science and/or technology. Each Board member should be a full-time worker, engaged all the time in looking after the work of the institutes in his charge, initiating new areas of research or technical development projects. The head of this Board should be invariably a military man so that there is complete liaison between the defence work in the field and the laboratories.

It is desirable to associate civilian scientists and engineers at all levels in these higher Military Institutes of Technology. A few of them can also be members of the Executive Board.

CHAPTER XX

TRAINING FOR CITIZENSHIP : COORDINATION BETWEEN TECHNICAL EDUCATION, GENERAL EDUCATION, SCIENCE EDUCATION AND PHYSICAL CULTURE

20.1 As already discussed in Chapter IV, the end and aim of all education is to develop such an integrated personality in the student that at the end of his education, he is in a position to take his place as a responsible citizen of the country. His mind should be so trained that it is kept active and always free from tensions, so that he can continually enjoy both in the hours of his professional work and the hours of his leisure. His body should be kept active and as healthy as the mind. He should grow up in a disciplined manner, which means that in his professional work he can wholeheartedly cooperate in executing the wishes of his superior. He should also have developed the necessary personality and will power to get his orders obeyed cheerfully by his assistants.

Training in general education, and in habits of discipline should start early in life before the mind gets so firmly set that it becomes difficult to change it. These should start at the elementary school and continue if possible as long as the end of a degree course, that is, roughly during the ages 6 to 22 years.

The present books on social studies are largely devoted to the description of the history of the constitution and how it works combined with history and geography.

These books should be rewritten bringing forth the difficulties faced in achieving independence, the importance of preserving it, the contribution each citizen is expected to make towards national integration and building a socialistic pattern of society, remembering at the same time that moral and aesthetic values are of permanent importance in promoting harmony in the individual and the community, in the country and the world. Physical culture and sports are absolutely necessary for inculcating discipline amongst the students. In addition, compulsory military training either in the National Cadet Corps or in any other form is a *must* for the defence of the country.

Appendix

Paper 7. 'The Crisis in Engineering Education' by B. Seshadri, paras 74 to 76.

CHAPTER XXI

ADMINISTRATION OF TECHNICAL EDUCATION

21.1 Development of technical education cannot thrive in isolation. It has to be coordinated with general education on the one side and with technical development on the other. Good coordination exists in all the States between general education and technical education. The Departments of Education in each State are in a position to make a unified survey of educational problems in all their aspects according to their requirements from time to time. They have a unified control over the entire system of education ensuring proper interconnections between different levels and types of education. This system has worked well. There is no reason why this set-up should be disturbed. There is thus a strong case why education should continue to be a State subject under the Constitution.

21.2 But for various reasons, mostly of finance and dearth of proper talent, the States have not made much headway either in (a) fostering research, or (b) in linking technical education with technical development in the country. It is in these fields of activity that the Centre can play its part effectively and usefully.

21.3 The States are mostly engaged in developing technical education at the graduate and undergraduate levels. It is necessary that there should be some sort of regulation and not regimentation in the activities connected with technical education. A high level policy making statutory or advisory body is necessary. It has to guide collection of data with regard to technical manpower requirements of all categories and also to get the progress in all aspects of technical education periodically evaluated. It should lay down broad principles of recruitment of teaching personnel, training of students and writing of text-books, encourage promotion of research in improving aspects of technical education up to the graduate level. and also suggest further diversification of courses periodically to keep in step with the advances made in industrial development, science or technology in this and other countries. It should ensure proper maintenance of standards. The present All-India Council of Technical Education with its regional organization is doing excellent work in the fields mentioned above. All that is necessary is to widen its scope of work.

21.4 The Directors of Technical Education, the Directors of Employment and Vocational Training, and the universities, look after, between them, technical education at all levels. As a result of the changes suggested here, the Industrial Training Institutes under the control of the Labour Department will have to be transferred to the Directorate of Technical Education. These will be called hereafter Higher Technical Secondary Schools. In addition, hundreds of them will have to be started all over the country. The entire system of apprentice training may continue to remain with the Labour Department. They may also start apprentice schools for giving education full-time or in the evenings to train students for Craftsman Certificate (Junior and Senior grade) examinations held on an all-India basis. They may continue to employ craft inspectors to supervise apprentice training not only in the bigger factories but also in small establishments specially in the villages.

21.5 The other two functions of technical education, those of furthering research and linking technical education and technical development, are activities which should be the sole responsibility of the Centre. The States do not have the finances nor can they recruit the personnel for this type of work. There will have to be movement of technical personnel from one institution to another which will not be possible if the personnel are under State service. A high degree of coordination of activities is required at national level at every stage.

21.6 Regarding promotion of research by running of all types of courses at post-graduate levels, these should be done at the Higher Institutes of Technology (I.I.T.s), the Regional Engineering Colleges, and other institutes which can do this type of work. Many new ones also have to be started. At least 75 per cent of the boys in these institutions should be engaged either in research or development and design courses. They should also be centres for running correspondence courses, holding external examinations at graduate and post-graduate levels, and where necessary, evening classes for training those in employment to appear for professional examinations. They should also be consultancy centres where industrialists can approach the professors for technical advice. Their services should also be made available freely for preparation of projects by industrialists anxious to improve or expand or start new industries.

In addition, the present Higher Institutes of Technology (I.I.T.s) and the Regional Engineering Colleges should be remodelled so that they work more or less like a university campus with a number of institutes (which may be called departments) in it. Each should specialize in a narrow field of speciality with its own Director or Chief Professor. The overall control of all these institutions and colleges which will be entirely financed by the Centre has to be under a full-time Technical Education Commission with a Chairman and two members. One of the members, the Administrative Member, will look after all financial matters, coordination in the purchase of equipment and recruiting of personnel, and such other matters of an administrative nature regarding all the technical institutions run by the Centre. The second member, the Technical Member, will wholly devote himself to technical work, to ensure maintenance of standards in examinations, suggest new courses to be opened, new areas for research, and all such other matters. He may have a small advisory body of experts to assist him, in which the Director General of the Council of Scientific and Industrial Research and the Adviser Defence Services can also be members. The Chairman, who should preferably be the Minister himself, should coordinate the activities of research and development not only in all technical institutes under the Centre, but also initiate, develop and coordinate research, development and design activities in the various universities and colleges under the control of the States. A policy similar to the University Grants Commission to foster areas of activity in one or two specialities at each of the engineering colleges and technical institutions at degree level in the States should be adopted. All the finances and the personnel connected with these activities should be completely under the Centre except for day-to-day control by the States.

The Chairman should also coordinate the activities of the Council of Scientific and Industrial Research with the activities in the technical institutions. He should also associate himself with the activities of the Ministry of Industries and Commerce, the Ministry of Irrigation and Power, and all other such Ministries which import equipment and raw materials in large quantities. It will be one of his important functions to initiate work of research, design and development of articles imported from abroad. He should also initiate work for substitution of scarce and costly raw materials imported from abroad.

A Minister has been suggested for this work, as he only can wield the necessary authority to get things done *quickly* and also can exercise his influence to advantage with the Ministers of Education in the States in all matters where their help is necessary. If this is not possible, any other person vested with the same authority as the Minister would exercise in respect of this Commission, may be appointed as Chairman. The Minister himself, or such a Chairman should be thoroughly conversant with all aspects of technical education from the highest to the lowest levels. He should have the personality, drive and tact to get things done quickly and efficiently.

21.7 *Internal management of Higher Technical Institutes*: Both the present I.I.T.s, the Regional Engineering Colleges, and other similar institutions proposed to be managed entirely by the Centre have to work as fully autonomous institutions in their internal administration if we have to get the best results from them. 'Academic freedom is a prime condition of learning and scholarship, of critical enquiry and scientific investigation, and its preservation in a world clouded with suspicion and men with hate is a vital and continuing task of this generation. Put in another way, the essential freedoms are easy to list, difficult to attain, freedom of thought and enquiry, of speech and publication ; freedom of syllabus and teaching method, freedom of teaching staff appointments made solely on grounds of academic competence and suitability, not due to extraneous conditions. These freedoms must underlie the whole educational system in a democracy.'[1] The present set-up of a Council, a Senate and Faculties is working well in most institutions. These should be retained. The Council should be the executive governing body that actively controls finance and external relations. It should be a small body consisting of not more than 18 members. It should have representatives of the Technical Education Commission, a member of the Ministry of Finance, representatives of professional institutions like the Institution of Engineers (India) and the National Institute of Sciences, representatives of industries, representatives of the Defence Science Organization, the University Grants Commission, Parliament, and the State Government where the institute is situated, and representatives of the universities in the region, the Senate, and the Faculties. In addition, a few distinguished persons well known for their learning and or administrative experience in the management of technical education should also be nominated. The Chairman for these Councils should be a member of the proposed Technical Education Commission. The Council proposed will no doubt consist predominantly of 'laymen' not experienced in teaching or actually doing research. This has been proposed because 'Where men and women of wide experience and high standing in the world of affairs can spare time to associate themselves with university (in this case institute) activities, the universities gain from the partnership strength and sagacity in their dealings with the outside world.'[1] Again, 'It should also be borne in mind that this Council can work harmoniously only when it recognizes a proper division of labour between itself and the Senate. Its function is to bring outside wisdom to bear on the external relations of the university and the evolution of its general policy, and to act as arbiter on matters that cannot be resolved by the academic staff. It is no part of its functions to interfere in the business of internal academic organization, still less in the matter of syllabi and curricula. The situation is likely to become intolerable if such attempts are made.[1] It is better to have the Technical Member of the Technical Education Commission as Chairman so that coordination in the activities and uniformity in policies of administration are ensured at all the institutes and colleges.

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[1] Technical Education' by P.F.R. Venables. *G. Bell & Sons, Ltd.*, 1956.

The Senate is the apex of academic activities. It should be composed entirely of academic members, all Professors and a few Senior Assistant Professors, one or two from each Faculty, the Librarian, the Registrar, and a Senior Accounts Officer of the Institute. These should zealously guard the academic freedom mentioned earlier in the same para. The prestige of an institute depends entirely on the responsibility, integrity and zealousness shown in the maintenance of standards and academic freedom by the Professors. The Council should remember that the achievement of high integrity and standards requires freedom and the opportunity to exercise responsibility. Unfortunately, in this country, Professors are hardly treated with any dignity. They have to work in an atmosphere of distrust and humiliation, *e.g.*, appointment of external examiners for setting question papers and correcting answer papers without reference to the Professor concerned, lack of authority to make small purchases of the value of even a few rupees for their laboratories, the throttling hold by the Ministry of Education at the Centre in the purchase of equipment for their laboratories, and many others too long to be listed here. This does not mean that objective evaluation of work done in a department should not be got done by external examiners occasionally, nor does it mean there should be no check whatever on purchases. This is in thorough contrast with the degree of responsibility entrusted to Professors in countries where technical education has advanced far ahead of ours. The Senate should be supreme in all academic matters. It should constitute its own committees of experts for recommendation for the appointment and promotion of all staff members below the rank of Professors to the Council.

The Faculties consisting of both junior and senior staff have an important role in preserving academic freedom. They should be able to advise the requirements of the courses. They should be permitted to experiment with methods and contents of courses, appoint external examiners for periodical assessment of work and maintenance of standards in the departments. They should also advise on entrance requirements, lengths of courses, etc. The decisions of the Faculties, though advisory, should carry great weight with the senate in its ultimate decisions.

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[1] 'Higher Education'. Report by Lord Robbins' Committee. Her Majesty's Stationery Office, London, 1963-64.

Appendix

Paper 6. 'Technical Education and Its Development (1966-81)' by Prof. S. Rajaraman.

CHAPTER XXII

LANGUAGE AND TECHNICAL EDUCATION

22.1 It is well recognized that a child can understand best when it is taught in its own mother tongue. If technical subjects can be taught in the regional language which happens to be the mother tongue of the majority of persons living in a region, there is another advantage. The children will spread technical ideas in their homes so that their parents and others in close contact with them will learn many things technical which may improve the efficiency of the tasks in which they may be engaged. These children serve incidentally as extension workers of technical education. The vocabulary of the language also grows richer by the addition of technical words. It is nothing unusual, in many of the highly developed countries, for practically everybody to know the names of all the parts of an automobile. Most of them even know their functions. This is partly due to their owning a car themselves, and partly due to easy access to literature in their own language. In addition, most of them learn even in their secondary schools how and why cars run. In our country, many graduates in mechanical engineering have hardly any familiarity with all the parts of a car nor do they know their names. There is practically no technical literature worth the name in the regional languages.

22.2 An immediate necessity is therefore to make a beginning by imparting technical education in the regional languages from the elementary levels right up to the first degree course in engineering. Before this is attempted, a beginning should be made immediately by encouraging authors to write text-books on technical subjects suitable at all levels up to the degree level. The technical terminology in all the languages to be used in writing the text-books should be settled. It is better to keep as many technical terms as possible common in all the languages so that it will be easy for a person from one region to understand the language of another from a second region.

22.3 At the degree level, English will have to continue to be the medium of instruction for a long time to come. There can be no two opinions that we should eventually replace English by Hindi as a link language. By sticking to English, we have unconsciously become slavish admirers of everything British. We have lost the capacity to make an objective assessment of the technical knowledge available in other countries like Germany, France, Russia, Japan and others. We have become such prisoners of our mind that we cannot even think of encouraging Indian authors to write text-books taking the best from all countries of the world. We have deliberately gone out of the way to kill Indian authorship by encouraging foreign embassies to sell their books even below the cost of production of similar Indian books. If it is considered that some books in the English language are excellent ones, the sensible way is to purchase a dozen or more copies of them for each of the technical institutions in the country to be stocked in their libraries for the use of students. Similarly, books in German and other languages should be got translated and copies of them stocked in the libraries of the technical institutions. The only way of getting out of the shackles which are binding us now is to boldly break away from them and make a start in thinking, writing and talking in our own regional language about all subjects however abstruse they may be. In addition to the regional language, Hindi should also be freely used as it is to serve as the link language for all of us.

22.4 Before we start using the regional languages and Hindi, we should concentrate on speeding up the activities of the present translation bureaus. *A few regional language and text-book institutes should be started in four or five places in the country, which will devote all their time and energies to bringing out text-books, and translating foreign ones into the regional languages and Hindi.* Private firms should also be encouraged to produce text-books which should be got edited and approved by these institutes before prescribing them. Recommendation has already been made that a start should also be made to publish a popular technical journal in English with its translation in all the other languages for the craftsman and diploma level. This will help considerably in paving the way for writing text-books and eventually teaching courses in the regional languages.

22.5 Both in the U.K. and the U.S.S.R. and in many other countries also, it is compulsory to study one foreign language either at the Secondary School or the first degree college level. In our country also, the same system is in vogue. The study of the foreign language, English, begins even at the fifth standard, that is, at the elementary school stage. This should continue to be so, as more than 50 per cent of world's knowledge is in this language. The system as it now prevails is such that the boys even after leaving the Secondary School have a working knowledge of the English language. With a little more effort, by studying for a year or two beyond the Secondary School stage, they are in a position to understand fairly well any book in English. This system should continue as long as the English language dominates in the world in its importance over the others. In addition, Hindi has to be learnt as a link language. A student at the graduate level will have command over at least three languages, the regional language, Hindi and English. It is not desirable he should be loaded with the study of a fourth language.

A study of a fourth modern language should be limited to only those who wish to do research work. This is absolutely necessary for research workers so that they know of the latest developments in countries other than the English language countries, in their own field of speciality. It should be compulsory for all research workers to study a fourth modern language, German, Russian, French, or Japanese. The standard to be aimed at should be to develop ability to understand and translate and technical article in a journal, if necessary by occasional reference to a dictionary.

22.6 Much more important than making a study of a modern foreign language compulsory for research workers is the opening of schools for teaching only modern languages. Like the Robbins Commitee, it is recommended that in all post-graduate technical institutes under the control of the Centre, a department of foreign languages should be established. One of the important functions of this department should be to translate foreign technical books and articles into English. The following recommendation of the Robbins Committee is pertinent to this discussion : 'A course involving the study of two or three modern languages, with the emphasis on standards in oral fluency, translation and interpretation, and combined with the study of the relevant background of the countries concerned, will attract students and would offer them opportunities to develop at a high level their ability to use the languages in fields where skill in a language needs especially to be supported by knowledge of the background in which the skill is applied.[1] These are required in great numbers for translation work, for promoting export of goods from the country, and for a variety of other purposes. Bright students who have completed their diploma education in engineering or B.Sc. in science should be encouraged to take up these courses. The duration of these courses may be three years leading to a B.A. (Hon.) degree in foreign languages.

Appendix

Paper 6. 'Technical Education and Its Development (1966-81)' by Prof. S. Rajaraman.

Paper 7. 'The Crisis in Engineering Education' by B. Seshadri, paras 30 to 34.

Paper 21. 'Medium of Instruction in Technology' by P. B. Katakkar.

Paper 22. 'Media of Technical Education' by K. Ramakrishnan.

CHAPTER XXIII

TEACHING METHODS—EXAMINATIONS—TEXT-BOOKS AND LIBRARIES

23.1 *Practice in the U.S.S.R. at craftsmen's level—Higher Secondary Technical Schools* : The extraordinary technical development that has taken place in the U.S.S.R. can be traced in a large measure to the revolutionary change adopted in their system of teaching to the students of the age group 6-17 years. This system was called 'polytechnicization'. To be a 'polytechnic', the courses of instruction must include vocational training. 'If the students are to be given only theoretical knowledge of scientific principles on which productive processes are based at the neglect of inculcating work skills, then the polytechnic instruction will have an absolutely theoretical character and will have poorly prepared the students for work. If only the work skills are inculcated without the theoretical knowledge of productive processes, then the instruction will not be a polytechnic instruction but a *sterile training in trades*'. To achieve the ideals of 'polytechnic' instruction, knowledge, abilities and skills must be developed in equal measure. In physics, for example, 'polytechnic' knowledge should include the most important application of physics in engineering and technology, such as metal fabrication, power generation and distribution, automation, radios, railroad, automotive and air transport. The abilities and the skills which must be developed in conjunction with the study of physics, includes the mastery of measuring techniques—determination of weight, specific gravity, pressure, velocities, efficiency of machines, temperature, specific heat, electric current characteristics, light and illumination intensities, and others—and the development of manual skills. As in this country, in the earlier stages, the U.S.S.R. faced the same problem of reorienting their education system as we are doing now. It has been noted '*the school is now faced with the responsible task of uniquely re-educating the pupils' psychology. Up to the present time, the school only prepared them for the institutions of higher education. Now when a considerable portion of those finishing school will go directly into life, our task is to nurture young people right from the beginning in the habits of work, in the love of work, and in respect for labouring people*'. How aptly this applies to us now ! If teaching is done in all subjects with this change in outlook in the thousands of Higher Secondary Technical Schools to be started or now working, the majority of these ordinary workers in the factories will work with a productivity raised double, may be many times more than now. Our industry will without doubt be lifted to a height beyond the reach of the industries of other countries.

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[1] 'Higher Education', Report by Lord Robbins' Committee, Her Majesty's Stationery Office, London, 1963-64.

In the U.S.S.R., schools are worked on a two-shift basis. We have to adopt the same system in view of severe shortage of school buildings and to meet the enormous demand for skilled craftsmen.

The syllabus in the U.S.S.R., for these technical schools consists of two parts. The first called 'explanatory notes' include a number of detailed directions on how certain topics should be presented, for example, 'in mathematics, in the tenth grade, in studying the volume of pyramids, the teacher may elect one of the two methods of presenting the topic described in the geometry text-books by A. P. Kiselev and by N. A. Glagolev'. The second part, the syllabus proper, lists in detail the topics to be covered, indicates the number of class hours in which each group of topics has to be covered, and the number of hours required by the students for home work. In mathematics, boys from age 11 to 12 years start practical work. They are taught to mark points and plot straight lines on ground, measure distances by pacing and by using a tape, lay out rectangular plots of ground and compute their areas. 'Soviet text-books on mathematics and science have been distinguished by the formality, directness and economy of the text, emphasizing theoretical concepts and using only a limited number of examples'. As one American physicist commented to the writer, 'A Soviet algebra text-book is algebra, not some version of 'consumer mathematics' with pictures'.

The All-India Council of Technical Education should appoint appropriate panels drawn from the teaching staff of polytechnics, Higher Secondary Schools, and others to write the syllabi for the various subjects. The syllabi should thoroughly cover the subjects and be drawn up in the same manner as in the U.S.S.R.' Instructions to teachers in assigning practical and home work to students and in the methods to be adopted for teaching the various topics in the subjects should also be drawn up in great detail for their general guidance.

The language and Text-Book Institutes recommended to be established at a few regional centres should take up the work of producing text-books.

23.2 *Examination system for the Higher Secondary Technical School Examinations :* In the U.S.S.R., most of the examinations are oral. It is of interest to note how Soviet oral examinations are conducted. The subject matter of each course is divided into about 60 or more topics. Two or more of such topics, briefly identified or structured in the form of equations, plus a problem (in such subjects as physics, chemistry and mathematics), constitute one of the approximately 30 'examination tickets'. At the time of examination, all 'tickets' are placed face down upon the examiner's table. As each student is called, he draws one of the tickets lottery fashion, or at the price of lowering his mark by one grade, he may gamble and draw a second choice. Having drawn his ticket, the student has 15 to 20 minutes to organize his answers before facing the examiners. The important point however is that the entire set of tickets with their questions is distributed weeks in advance. No actual problems such as in mathematics are known in advance, though the type of problem to be set is intimated earlier. The last weeks of each year, therefore, are spent in review and drill by tickets and specific questions. This method relies no doubt mostly on memorization. But the scope of the final examination questions is so comprehensive that it demands thorough preparation and review, whether by route or otherwise.

There is general agreement that our methods of conducting examinations are very defective. The U.S.S.R. method is also open to many objections. It is firstly time-consuming. It leads to excessive cramming and is no test whether a boy has really understood the subject and whether his thinking faculty has improved as a result of the course he has undergone. It is difficult to maintain uniform standards if there is oral examination at all the places simultaneously.

The following system which is a combination of both the U.S.S.R. and our methods may be tried in a few places as an experimental measure. For each region, there should be a Controller of Examinations whose duty it is to conduct examinations and declare results. With the help of appropriate boards, he appoints question paper-setters in each subject. The question paper-setter sets 20 or more questions covering the entire subject. These questions are divided into six or more groups A, B, C, D, E, F, and so on. The number or groups should equal the number of questions the candidate has to answer in the time allotted to him. Each group will contain two or three questions *taken from the entire syllabus.* The Controller of Examination draws lots, and fixes well in advance of the examination the number of the question in each group which has to be answered by a particular roll number : for example, roll number 10568 may have to answer question 1 in Group A, question 3 in Group B, question 1 in Group C, and so on. This arrangement will apply to each of the question-papers to be answered by the candidate, without it being necessary for the Controller of Examinations to draw lots for each question-paper separately, for example, roll number 10568 will answer question 1 in Group A, question 3 in Group B, question 1 in Group C, and so on in all the papers in which he appears. If he cannot answer any question in a particular group, the candidate can choose any other question in the same group, but the question will be corrected for a maximum of half the marks allotted to the question in the group. All answers should be written ones generally. There should be practical and oral examinations in laboratory work and workshops. The answer papers should be corrected mostly by the teachers themselves who are handling the classes. After the examination is over, all the paper-correctors will assemble in the same rooms where the candidates were sitting. Sealed packets of answer-papers will be brought by the head of the institution, the seals broken open in the presence of the paper-correctors, and the papers got corrected. Those which remain uncorrected are sealed again and delivered the next day in the same manner as above. They should be paid suitable remuneration for this work. The answer-books together with the marks sheets should be sent to the Controller of Examinations. He will declare results in two parts in each subject, the marks or grade the candidate has obtained in the first part which is based on the assignments, tests, etc. of the candidate in his school, and the grade or marks the candidate has obtained in part two which is based on his performance at the external examinations. The advantage of this system is that no boy can hope to pass an examination by studying only half or a part of the prescribed syllabus. Since the choice of questions he has to answer is made at random, he has to prepare himself to answer questions from all portions of the syllabus.

Instead of our marking system, the grading system adopted in American schools, now adopted by a few of the Indian universities, is more rational and should be adopted in declaring results.

The year should be divided into two terms, each of six months duration. One month's holiday in each of the terms may be given. Each term should be an unit in itself so that fresh admissions are made once every half year, instead of yearly as now being done. This will prevent wastage of time by students passing in the September examinations. The students are also kept continually alert as they have to face examinations every half year. They can study better as the portion to be answered in a half year is less than in a full year. Since the declaration of results is in two parts for each subject, boys have to be continually alert as failure in any part will entail repetition of the course in the subject. The employers can also judge the regularity of the habits of the boy by his performance in the school, assignments, tests, and the practicals. This system will prevent or at least lessen student indiscipline in schools as the boys have to work all the time during the year. The results should be declared within two weeks after the examinations. After the results are declared, the Controller should get a percentage of the answer papers revalued every year by different sets of examiners. Those guilty of misconduct or inefficiency should be removed, and their place may be taken by other teachers in the same school or in the neighbouring schools.

23.3 *At the diploma and first degree levels :* The writing of syllabus, text-books, the methods of teaching, the method of holding examinations every six months, and declaration of results in two parts, may follow the same pattern. In addition to written examinations, there should be more of oral and practical examinations in each subject. Instead of the Controller, a Chairman of Board of Examiners should be appointed for each region or university.

23.4 *At the post-graduate degree levels and doctorate levels :* Each institution should have full powers to frame its own syllabus. A certain number of the staff members should be given leave and other adequate facilities to write text-books every year. No staff member should be given leave just to edit or revise a text-book. Authors should be adequately paid for doing this work. Methods of teaching to be adopted, the number of hours for each topic, etc. in each subjects should be settled at the beginning of each year at a meeting of all the teachers of a particular Faculty. At these higher institutes which run post-graduate courses, there should be one or more Faculties for practically every subject like Civil Engineering, Mechanical Engineering, Physics, Mathematics, etc. Each institute may be allowed to develop its own method of holding oral, written and practical examinations and the method of defending thesis. At all oral examinations including those at the time of defending of a thesis, at least two outside examiners should be associated, one an acknowledged expert in the field to be appointed by the Senate, and another who has rich professional experience outside the academic field. He can be a nominee of a professional institution like the Institution of Engineers (India). It should always be open to these outside examiners to call for answers of written examinations and review them. The Chairman of the Faculty will be the final authority in all matters concerning his Faculty. The Senate on getting reports from the Chairmen of the Faculty or Faculties in the several courses offered by a candidate will consolidate them and declare results, using the same grading system. It is unnecessary to declare results in two parts.

23.5 *Libraries and journals*: Libraries should be under qualified librarians. There should be ample space for boys to study in the library premises. They should be kept open daily from 8 a.m. to 10 p.m., the library staff working in two shifts. Where this is not possible, they can be kept open in the evenings from 4 p.m. to 10 p.m. daily, including holidays. The books and journals stocked in the libraries should be such that they are easily understood by the students. They should also contain books and journals useful to the teachers as well. Teachers should not be allowed to borrow books or journals meant for students.

Appendix

Paper 7. 'The Crisis in Engineering Education' by B. Seshadri, paras 41 to 47.

Paper 8. 'The Teaching and Examination Structure of the Five-Year Integrated Degree Course' by Prof. P. S. Kalwachwala and Prof. A. K. Mehta.

Paper 23. 'System of Engineering Education' by N. Sidheswar and N. Rama Rao.

Paper 24. 'Examination in Engineering Colleges' by Dr. M. L. Jain.

CHAPTER XXIV

FINANCE AND EQUIPMENT PLANNING FOR TECHNICAL INSTITUTIONS

See paper 25, 'Equipment Planning for Technical Institutions' by Prof. P. S. Kalwachwala and Prof. A. K. Mehta.

CHAPTER XXV

TEACHERS' WELFARE AND THEIR RECRUITMENT

25.1 The success of any scheme of technical education depends to a considerable extent on the quality of the teaching staff and the proper administration of the college.

The method of recruitment followed now is meeting satisfactorily the requirements of teaching staff up to the first degree level of the technical education. The method of recruiting staff for the first degree and post-graduate courses has already been discussed.

Part-time teaching staff make an indispensable contribution to the work of technical institutions, coming as they do from all walks of life, and particularly welcome are those with wide experience and holding positions of responsibility in industry and commerce.

25.2 Most teachers achieve proficiency only after years of practice. It is better that every teacher, whatever may be the level, from the lowest level to post-graduate levels has a period of instruction in teaching techniques before he takes up his duties. These teacher training courses may be offered as a full-time course in special Technical Teacher Training Colleges. This training is very essential for those who have to take up their duties as teachers in Higher Secondary Technical Schools and polytechnics. The in-service courses are also offered to those who are recruited from industry and have gathered about two years of teaching experience. Under this system, the teachers attend the course one day per week for three terms with pay, and if need be, travelling expenses. The courses comprise general and special teaching methods, together with a brief treatment of such general topics as educational psychology and history, more especially the organization of technical education. There can also be regular evening courses and correspondence courses with practical training during summer vacations arranged in attractive surroundings.

25.3 There should be free interchange of teachers in schools with those of foreign countries wherever this is feasible.

25.4 Every teacher should be entitled to sabbatical leave to go abroad for study and research. This should be encouraged specially amongst teachers handling graduate and post-graduate classes.

25.5 Directly related to the quality of teaching is the encouragement offered to teachers to keep themselves abreast with the latest technical developments in their subjects and in the theory and practice of teaching their subjects in technical institutions. This is best achieved by insisting that every teacher should join a professional institution like the Institution of Engineers (India) either as an Affiliate Member if he is a diploma holder or as a Corporate Member if he is a graduate. He can have access to all the latest literature available in his field of speciality as well as in technical education, as the Institution of Engineers (India) deals with all aspects of engineering and technology including teaching. His contact with professional engineers in industry will greatly help him to orient his teaching or research to the requirements of industry so that his students do not find themselves misfits when they enter industry. Every teacher should be given a small allowance each year to cover the cost of joining such institutions and purchasing a few technical books and other accessories for his personal use. All teachers whose papers are accepted for publication should be deputed to attend the meetings where their papers are discussed. Others who can usefully contribute to technical discussions should also be deputed. The Central Government should finance this expenditure, as well as that of deputing teachers abroad for higher studies or for research work in particular fields. They should also finance teachers by meeting their salary and necessary expenditure during the period they are deputed to write text-books. The teachers should not be asked to surrender to the Government any portion of the royalties obtained from writing and sale of the text-books. These should be done in the larger interests of the country as a whole, as investment in increasing the efficiency of a teacher results in increasing the efficiency of his students, who in their turn increase technical development and national wealth.

25.6 The next is the problem of apportioning hours of work for a teacher, the number of hours he has to spend in lecturing, tutorials, correcting home assignments, organizing group discussions amongst students, doing research work, and administrative work. In research work again, the time he is to spend on giving technical consultations to industry, the time he is to spend on designing and fabricating equipment of new types, and the time he has to spend in guiding students for obtaining research conferments like M.Sc. and Ph.D., have to be determined. There can be no hard and fast rules about these, as the apportionment of work depends on a close and intimate knowledge of the capacity of each and every staff member. It is absurd to think that any one of the various types of work mentioned above is superior to another. All are essential for development of technical education. The head of each Faculty or department in post-graduate institutions and colleges for training students for the first degree should be the sole judge for allocating work amongst the members of his staff, subject to the overall approval of the Senate or College Council or by whatever name the academic body is called.

25.7 The next point for consideration is the relation between the Director, Principal or Head of an institution and the teachers. At present, unlike in the Western countries, the Director or the Head of the institution is all powerful. Instances are not wanting where Directors ask their Registrars to reply to letters directly addressed to them by the Professors. Professors have to fix up engagements with the personal clerk to see the Head. In some institutions, Professors are kept waiting for hours before they are received. All this because we have still not got over the old I.C.S. methods of bossing prevalent under the British rule. The government and the governing bodies or advisory bodies of the institutions or colleges are entirely guided by the Director or the Head. Directors sometimes bring their own prejudices to bear on subjects concerning the recruitment and future of the teaching staff. Most Professors are indifferent to the problems concerning the development of their institutions owing to a feeling of frustration that their words hardly carry any weight. It is therefore necessary that the Senate or the College Council should be the sole authority in all academic matters in autonomous institutions. In the universities, the recommendations of the College Councils should be implemented by the Syndicate. When the Syndicate differs, the recommendations should be sent back to the College Council for review with reasons as to why it is unwilling to accept the recommendations. Although the final decision may rest with the Governing Councils or the Syndicates of the universities, the fact that these attach considerable weight to the opinion of the Professorial Councils brings prestige both to the Professors and the institution. The Head should merely voice the opinion of the Professorial Council. The Head of an institution may be appointed for a period of five years at a time. The appointment may go round by turns amongst the Heads of departments, or the Head of the institution may be given further extensions in periods of five years at a time. No hard and fast rule can be laid down for the procedure to be followed. The procedure to be followed is a matter which should be left entirely to the Governing Council or the Syndicate of the university. The recommendation that can be made is that the Heads of institutions may be appointed for periods of five years at a time, so that the other heads of departments may also have a chance of their being considered for promotion. During the time the head of a department is also the Head of the institution, he may be given a higher grade, which he should not lose if he reverts back to his own post at the end of his term. Many Heads of institutions would like to do so of their own free will, if they find professorial work is more interesting than administrative work, and also if their emoluments do not suffer any reduction by such reversion. This procedure will bring a 'democratic atmosphere' in the institution, creating a climate in which academic achievements can grow congenially.

25.8 The present proportion of teachers to students at all levels of technical education is thoroughly inadequate. This requires to be corrected. In the U.S.S.R., it is 10.3 to 1, and in the U.S.A., it is 12 to 1. In this country also, a ratio of 10 to 1 may be taken as a guide for all institutions up to the degree level.

For the degree level, work load for each staff member should be the main criterion. The ratio of teacher to students naturally varies with the number of electives the college is offering in its courses.

At the post-graduate level, work load should be the only criterion. The number of subjects taught and the tempo of research and development work going on in the institutes is a major factor for consideration. Another important factor is the amount of work done by the teaching staff in consultation work. Every effort should be made to encourage such types of consultation work which will lead ultimately to problems of applied or basic research in the laboratory or in the field, or in taking out a patent for a process, or in the design of new types of equipment. Consultation work of a routine type mainly bringing in money to the staff is not a desirable activity. But consultation work which leads to widening or deepening of technical knowledge deserves every encouragement. Generous increase in staff should be allowed in all departments or faculties in post-graduate institutions where research or consultant work is being carried on vigorously, or even when there is scope for such activities being taken up. There should be nothing like a teacher-student ratio in such institutes of higher learning.

25.9 The ratio between senior and junior positions in technical institutions is a subject which requires careful consideration. So far as the Higher Technical Secondary Schools are concerned, the recruitment of staff should be the responsibility of the State Governments. The ratio of senior to junior positions has naturally to be fixed by the State Governments, taking into consideration such a division sanctioned for the Higher Secondary Schools. But it should also be noted that technically qualified staff can only be recruited if they are offered at least the same emoluments corresponding to the positons they would get in the technical departments of the same Government or in industry in the public and private sectors.

So far as diploma and first degree courses are concerned, the position is different. It has to be largely functional. For the diploma course, the Head of the polytechnic has to be of the grade of a Professor. The heads of various departments have to be of the grade of Assistant Professors and the rest of the lecturing staff have to be Lecturers. There may also be a few Instructors to correct home assignments and to hold practical and laboratory classes. In addition, all Lecturers who have put in 15 years of satisfactory service s Lecturers or in equivalent posts in industry or otherwise and have obtained at least a first degree in engineering, science, or its equivalent should be promoted as Assistant Professors on a personal basis. Similarly, all those who have obtained a Master's degree and have put in 25 years of service on the aggregate as a Lecturer and an Assistant Professor and in equivalent posts in industry or otherwise should be promoted as Professors. Assistant Professors and Lecturers should be encouraged to study for M.E. degree courses in Industrialist Engineering. This knowledge will be extremely useful in giving them the necessary technical knowledge and the psychological orientation necessary for training students for industry. In addition, all the Lecturers should undergo training for a year in a Technical Teachers' Training College. Both Professors and Assistant Professors should be members of a professional institution. This arrangement will go a long way in removing frustration amongst the senior staff members who will be stagnating for years without promotion, and prevent them from changing over to industry just for the sake of earning the extra finance to meet their nneds which grow normally with age. At present, many are compelled to change their jobs after long years of service, though they are used to and like their jobs, for no other reason except for getting more money. At the first degree colleges also, the same principles can govern the allocation of senior and junior positions. In a college, there should be a Professor for each of the branches as suggested previously. In addition, there should also be promotions from Lecturers to Assistant Professors for all those who have satisfactorily completed 10 years of service as a Lecturer and in equivalent jobs, provided they acquire a Master's degree in engineering and are members of a professional institution. Similarly, Assistant Professors with M.E. or M.Sc. qualifications should be promoted as Professors if they have on the aggregate (in the same manner mentioned above) put in satisfactory service of 25 years. For those who have a doctorate, a reduction of 5 years and 10 years respectively may be given for promotional posts of Assistant Professors and Professors. The years of service are to be counted, in all cases, from the year of taking the first degree.

For those conducting post-graduate courses, different rules have to be applied. Every Chairman and the heads of departments in each faculty of a post-graduate course should have at least one Professor. As already recommended, what is now considered as a branch of engineering like Civil Engineering will hereafter be called the Faculty of Civil Engineering in a post-graduate institution. Every head of a laboratory or those guiding not more than five students in the dissertation courses, design and development or research work should be an Assistant Professor, that is, there should normally be one Assistant Professor for a maximum of five post-graduate students. There should be a

Lecturer for every speciality. There should also be promotional vacancies which should be filled up in the same manner as indicated in the previous paragraphs.

There should be a system of out-of-turn promotions in recognition of exceptionally good work.

25.10 Regarding service, the age of retirement in all cases where there is heavy lecturing work should be 60 years normally. Further extensions year by year may be given in deserving cases.

In case of teachers whose work is more in the nature of guiding research, design and development projects, and consultative work with industry and administraton and as such does not involve much of actual lecturing, the age of superannuation should be 65 years.

Professors doing post-graduate work should not be allowed to retire from professional activities, though they may generally cease to do administrative work after attaining 65 years of age. They should be allowed to work as long as they can on a suitable remuneration in the same or other institutions of their choice. This generosity shown to a few professors in the country will go a long way in enhancing the prestige of the profession and attracting the best talents to this profession.

25.11 Regarding salaries, this is a matter which should be settled taking into consideration the salaries and prospects of persons of the same qualifications and merit when they get into employment in the private and public sectors. These change from time to time and no hard and fast rule can be adopted.

25.12 Teachers should be given all social security benefits such as insurance, sickness, pension and gratuity benefits. They should have at least the same medical facilities as those under the Employees State Insurance Schemes.

25.13 Construction of quarters for teachers in most places should be taken up on a large scale. There is great difficulty for teachers to get quarters at reasonable rents.

25.14 There should be frequent interchange of places between teachers and executives in industry. These should be encouraged till the professorial level. Professors should not be allowed to work in industry dislocating their work in the college. After once they have become Professors, there is no question of leaving their faculty for long periods.

25.15 There should be a system of recruiting qualified persons from industry for part-time teaching or laboratory or practical work. Certain subjects can be handled better by men in the profession rather than by teachers wedded to a purely academic life.

25.16 There should also be a system of employing post-graduate students also both for teaching practicals and correction of test papers. This will also help post-graduate students to develop the art of expressing themselves in a methodical and lucid manner.

Appendix

Paper 3. 'Wither Engineering Education?' by N. Sidheswar and N. Rama Rao, Sections 7 and 8.

Paper 6. 'Technical Education in India and Its Development (1966-81)' by Prof. S Rajaraman, para 5.3.

Paper 26. 'Measures for the Promotion and Improvement of Teachers and Strengthening of Technical Institutions' by Prof. M. V. Deshpande, Sections 1 to 9.

Paper 27. 'Basic Need of Engineering Education in India' by Dr. Jai Krishna.

Paper 28. 'Education and Training of Technical Teachers' by Prof. R. Khanna.

CHAPTER XXVI

STUDENTS' WELFARE, STUDENT ADMISSIONS AND DISCIPLINE

26.1 *Information about technical education :* The opportunities afforded under the proposed scheme for all students to study right up to the highest level, the preference shown to students in the matter of admission from one lower course to a higher course, the pay and prospects of students completing the courses, the scholarships available, and a host of other information useful both to students and to their parents should be published widely. These can be prepared in the form of brochures. Each brochure may deal with a particular level of course offered, a particular aspect of technical education like variety and amount of scholarships available, variety of courses offered, opportunities for employment, and so on. These should be printed in all the regional languages and in English and distributed freely to all elementary schools, high schools and other places which are likely to attract the attention of the students or their guardians. This should be an annual feature and should be done without fail.

This work should be entrusted to the Language and Text-Books Institutes proposed to be established at a few regional centres.

26.2 *Selection of students :* There should be no difficulty in the matter of selecting students to the Higher Secondary Technical Schools. Till people come to know that the technical school is the main feeder for higher technical education, a good number of scholarships may have to be provided to induce students to join these schools.

Selection of students for diploma and first degree courses should be strictly on merit, based on the candidate's performance both in the class assignments and the final examinations. As marks for class work are likely to be boosted, only those who have got above a certain minimum should be considered as eligible for admission to the technical courses both at the diploma and degree levels. From amongst the eligible, a further list strictly in the order of merit based on the performance of the candidates in the public examinations should be made. There is no harm in making reservation of seats according to statutory requirements for those belonging to scheduled classes, hill tribes, children of defence personnel whose parents have died in action, and so on. Even in these, selection should be by merit amongst those belonging to each of these categories. Selection by merit is psychologically important, as every boy must feel that he has been admitted by merit. If, on the other hand, he is made to feel he has been admitted on communal or other grounds, he will have this feeling right through life, and will feel that in turn he has to repay his community for the admission he secured through its influence.

Where marks have to be considered from more than one Technical Board of Examinations or university, common entrance examinations may be held for each region, specially for admission to the polytechnics.

The present system of selection of students for the Indian Institutes of Technology is a good one. It should include all applicants to Regional Engineering Colleges also, and such other colleges which would like to join in the scheme. The system takes into account the previous academic records of the boy as well as his performance at the entrance examination.

For admission to post-graduate institutions, the Senate of each institution should determine its own methods of selection.

The practice of students being given admission to private technical institutions on payment of 'donations' should be severely condemned, as it goes against the very fundamental principle of education which is recognition of merit. Merit and merit alone should be the sole criterion for admission. Such private colleges, if they so desire, can charge enhanced fees.

Every year an Admission Board should be formed, which will prepare lists of candidates eligible for admission strictly in the order of merit under the various categories, general and reservations (scheduled classes, etc.), under which admissions have to be made. It is only from this list that offers of admission should be made, following the one below rule, when anyone who has been offered admission fails to join the course. Private colleges must be made to pick out candidates from the same list, following the same one below rule, when any candidate fails to join their institution.

26.3 *Contact between students and teachers*: Lecturing to the classes is one method of instruction to the students by the teacher. In addition, in practicals and workshops, the teacher comes in closer contact with the boys. In addition, each teacher should be assigned 20 to 30 students to his charge. It is his duty to meet them individually, at least once every two months, and talk to him about the progress of his studies, his difficulties regarding purchasing text-books, submitting assignments and maintaining regularity of attendance, and other matters of a personal nature. The interview should last at least 15 minutes for which the teacher may be paid at the rate of one rupee per student. It is left to his discretion to meet the student in his house over a cup of tea or in the college. He may also inspect the notes he has taken in the class. If there is anything unusual which he thinks he ought to report to the guardian of the student, he should do so. The college will no doubt be spending at the rate of Rs. 6 per student per year which can easily be recovered from the student by adding this amount to his library fee, which may be called library and cunselling fee. The effect of this will be that the student will feel a greater sense of security as he is now under the shelter of a teacher. This will also lead a better maintenance of discipline as every teacher can control the student as he has personal contact with him.

'In the educational revolution that we are living through, there is a special and mounting problem of large numbers of young people coming to universities without a background of higher education and culture in their homes. They need to be given a sense of security and confidence in what is to many of them a disconcertingly strange and impersonal world.' These sentiments are equally true of this country.

26.4 *Students and wastage in technical courses*: It is not all students who enter a course that get out of it after successfully passing the final examination. Some wastage is no doubt inevitable in any system of education. There will always be a certain number of students who discover that they have made a wrong choice, others who prove unable to develop intellectually much beyond the point they had reached on entry, and some who withdraw or fail because of ill-health or other personal reasons. Generally, the order of wastage in our country is as high as 40-50 per cent at the degree levels. This is due partly to inadequate guidance by the teaching staff. Wastage can be reduced by appointing paid counsellors (teachers) to look after the students as mentioned in para 25.3.

26.5 *Students and examinations*: It is most unfortunate that our system of examinations is such that the boys are always kept in great tension just at the time of the examinations. Most do hardly any work during the rest of the time. In order to spread their work evenly throughout the year, marks should be assigned for home work. In order to obviate personal influences getting in the evaluation of home assignments, final results should be declared in two parts as already recommended. Since, examinations are to be held once every six months as in American universities, and admissions are also made once every six months, wastage will be reduced to a minimum. Students will also have their work spread out better. The strain is also eased, as they will be examined only in the portions covered in each term. Students should also be given the facility of passing subjectwise. No student can go to the class in the next higher term unless he has cleared the subjects in the previous term.

26.6 *Students and lodgings and medical facilities*: The students are obliged to live under miserable conditions, three or four in a room, travel long distance to colleges, and eat in tenth-rate hotels. The two things every student should have is a room of his own however small it may be, and facilities for social life. Hostels with single rooms are a necessity. The present programme of building such hostels requires acceleration. Hostels should have rooms for praying, reading, holding debates, showing educational films, facilities for indoor games, music and acting, and all such activities which gives recreation to a student.

26.7 Suitable medical facilities should be provided for all students.

26.8 *Students—sports, gymnasiums, N.C.C. activities and Students' Unions*: These should be actively encouraged.

26.9 *Students—college day celebrations*: These are occasions when students come in contact with the older boys. In addition, there should be open college days when the college laboratories and museums can be thrown open to the public. Some of the colleges can give their own awards to their students who have distinguished themselves either in studies, sports, or other activities. Membership of the college may be conferred on these boys, and certificates awarded at college convocations specially held for this purpose. Some of the teachers should also be given these membership awards. All these activities will foster pride in their colleges and brotherhood among their alumni.

26.10. *Students and hobby clubs*: Model making in technical institutes is a very important activity. Every technical institution including Higher Secondary Technical Schools should have museums attached to them, where a few of the models made by the students should be exhibited.

26.11 *Students and scholarships and wages*: Generous scholarships should be given both to the needy and to the merited students. Even the scholarships given to needy students should be called poverty-*cum*-merit scholarships. Every student should be made to feel a sense of pride and self-confidence that he has earned a scholarship and not succeeded in begging for it. Students should also be encouraged to earn wages by doing manual work in the college campus where necessary. Senior students may be paid wages for correcting home assignments and test papers of junior students.

26.12 *Students and loans*: Loan scholarships should be given to students coming from middle class families to complete their education. These should be payable after the student starts earning.

26.13 *Students and co-operative societies*: Co-operative societies in every technical institution including Higher Secondary Technical Schools for supply of books, instruments and other requirements of students should be formed.

26.14 *Conclusion—privileges and obligation*: The following extract taken from the Robbins Report on 'Higher Education' is relevant for this report: 'In this age and country, students are a privileged population; they have exceptional opportunities provided for them by the labour of their parents and the community. They are under the obligation to make the best of their three or four years and to remember, as Milton did, that 'Ease and leisure is given thee for thy retired thoughts out of other men's sweat'. Public opinions will not support the cost of higher education unless teachers are actuated by a high sense of professional obligation and students are actuated by a corresponding sense of the obligations to work'.

Appendix

Paper 3. 'Whither Engineering Education?' by N. Sidheswar and N. Rama Rao.

Paper 29. 'Problem of Maintaining Discipline Among Students.' by Prof. G. D. Joglekar.

CHAPTER XXVII

RESEARCH AND STATISTICAL ORGANIZATION FOR DEVELOPMENT OF TECHNICAL EDUCATION AT ALL LEVELS

27.1 There can be no progress without research. The very methodology of research requires (*a*) programming the result to be achieved, that is, fixing the object to be achieved by investigations; (*b*) collection of data of what has been done both in and outside our country; (*c*) detailed study of data to find out deficiencies and achievements; (*d*) planning and conducting investigations; (*e*) collection of data from these investigations; (*f*) arriving at conclusions; (*g*) generalising them; and (*h*) publicising them for general adoption.

27.2 A research and statistical organization which deals with all the main aspects of research in technical education at all levels is a vital necessity for both general and technical development of the country. This needs no argument, about the need for such an organization. Its functions can be as under:

(*a*) It will collect in formation on all aspects of technical education and systems in vogue in various countries.

(*b*) It will collect data with regard to (*i*) output of technically qualified men at all levels, (*ii*) technical manpower requirements at all levels, regionwise, and industrywise, (*iii*) technical manpower requirements at all levels to start new industries, or expand existing ones according to programmes of the Planning Commission, (*iv*) increase in productivity as a result of giving regular training to craftsmen, (*v*) increase in economic growth, and growth of science-based industries employing high level technical personnel such as the chemical, electricity, electronics, petroleum, automobile, machine tool, and heavy electrical machinery industries, as a result of newer methods of technical education imparted to students, (*vi*) requirements of technical personnel for the growth of industries manufacturing new products and new devices for automation of technical processes, (*vii*) requirements of technical personnel for industrial research, (*viii*) for export and reduction of imports of machines and spares, and (*ix*) all other data necessary for linking technical education with technical development.

(*c*) It will periodically review what the purpose and aims of technical education should be.

(*d*) It will determine the levels at which technical education has to be imparted.

(*e*) It will investigate methods of coordination between technical education, science education and general education.

(*f*) It will investigate how to correlate increase in output of technical personnel at various levels with increase in industrial output and with increase in the standards of living of the common man.

(*g*) It will also investigate the effect of technical education on general standards of morality, integrity and behaviour, and other aspects concerned with the general well-being of society.

(*h*) It will investigate the place of languages in imparting technical education.

(*i*) It will investigate the various methods to be adopted for maintaining standards in technical education, for periodical revision of curricula, and for opening of new courses.

(*j*) It will investigate the various methods of imparting knowledge of the latest developments and techniques in science and technology to those in employment.

(*k*) It will also investigate the best method of giving publicity of the facilities available for technical education.

(*l*) It will investigate how best to correlate the activities of technical institutions with the activities of the University Grants Commission, the Council of Scientific and Industrial Research, and other research bodies in the private and public sectors.

(*m*) It will investigate all problems pertaining to teachers' welfare, teaching methods, text-books, teaching aids and reading materials.

(*n*) It will investigate all problems pertaining to students' welfare.

(*o*) It will investigate all problems pertaining to administration of technical institutions.

(*p*) All other matters which are directly or indirectly connected with technical education at all levels.

27.2 This organization should have a full-time Director assisted by numerous advisory panels. He should work directly under the Technical Education Commission.

Appendix

Paper 4. Consensus of 'Seminar on Technical Education and Its Development (1966-81)' held at the Bengal Centre.

Summaries of Papers Published in the Journal, vol. 46, no. 1, pts. CI 1, ME 1 & ET 1, September 1965

CIVIL ENGINEERING DIVISION

The Seven Depths in Prismatic Channels

Prof. R. M. Advani
Member

A brief analysis of the computation of seven depths in prismatic channels is presented in this paper. These depths are: the uniform or normal depth, the critical depth, the end depth, the two alternate depths, and the two sequent or conjugate depths. As far as possible, the various equations have been expressed in the non-dimensional form so as to make them universal in application.

Photogrammetry for Civil Engineering

A. K. Biswas
Non-member

Photogrammetry is the science and art of utilization of photographic principles to the science of mapping. Aerial photogrammetry derived considerable impetus due to to its usage in military activities during the First and Second World Wars. In the last few years, development of faster and more accurate instruments as well as the integration of aerial surveying and electronic computers has tremendously increased the use and scope of photogrammetry. No doubt it is going to be more and more important in future. The gradual perfection of infra-red scanners, compact television cameras, radar systems, controllable satellites, etc. will enable man the photo-interpretation of the planets and stars, besides the conventional applications. This paper describes the historical development of photogrammetry and analysis the technical features of the various equipments required in the process.

An Application of Critical Path Method for Construction Planning

C. B. Patel
Associate Member

The object of construction planning is to complete any given set of activities in a predetermined sequential time schedule to obtain the end result, *i.e.*, the completion of the project. To this end, engineers have so far been using the 'bar charts' as a tool to guide them follow up a project. Bar charts have definite limitations and do not give adequate information about the progress of the project to control it effectively. Bar charts do not indicate the activities which are critical for the project and which effectively control the project completion time. In the preparation of a bar chart, planning and scheduling is done simultaneously, with the result that the sequence of activities, their timing and the relationship between the various activities cannot be planned effectively. The effects of all these shortcomings have been felt on all large projects. The critical path method is a useful tool for construction planning and it obviates all the disadvantages of the standard bar programme and progress chart.

Effect of Cement Quality on Coarse Aggregate Requirement in Cement-Concrete Mix*

G. G. Kelkar

Student

Design of Panset Dam Spillway Based on Hydrology of Catchment Region*

G. G. Kulkarni

Associate Member

Pneumatic Sinking of Well in North Koel Bridge Foundation*

Vijaya Singh

Non-member

ROADS AND ROAD TRANSPORTATION GROUP

Planning of Highway System in Assam*

G. C. Sharma

Member

MECHANICAL ENGINEERING DIVISION

Effect of Organometallic Compounds on the Ignition Temperature of Carbon and Engine Deposits

Dr. B. S. Chittawadgi

Non-member

and

Prof. A. N. Voino

Non-member

The ignition temperature of engine deposits appears to be an important factor in the combustion process of an internal combustion engine with spark ignition. Some authors have showed that piston deposits are responsible for the phenomenon of rumble. This paper describes the experiments conducted in a specially designed laboratory-type furnace to determine the ignition temperature of engine deposits and carbon formed in diffusion flames. The experimental results are discussed and it is shown that organometallic additives reduce the ignition temperature of carbon deposits.

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* Summaries of these papers have been published in the *Bulletin*, vol. 14, no. 9, May 1965.

Diesel Smoke

T. V. L. Rao

Associate Member

This paper studies the feasibility of improving the combustion characteristics in a Diesel engine with a view to eliminate smoke, suppress noise and reduce the cost of operation and maintenance. Based on a study of reaction kinetic of combustion and the associated problems, the effects of secondary fuel injection and film vapourization on the elimination of smoke are analyzed. The other features of combustion in a Diesel engine, *e.g.*, augmentation of supply of air and its utilization, atomization, vapour formation, mixture distribution, provision of adequate velocity to the air, and construction of the combustion chamber, are also studied.

Machinability of Materials Difficult to Machine

Prof. V. V. Tsotskhadze

Non-member

The quest for alloys of high strength for operating at high temperatures such as in gas turbine blades, etc. has posed a big problem to the machinist. The fabrication of such units at room temperature results in low productivity and several investigations have been directed towards hot machining of these materials. However, the selection of optimum conditions has not been fully achieved. In this paper, the investigations carried out for machining preheated difficult-to-work materials are presented. The results are analyzed and suitable relationships are formulated to select optimum working conditions, based on a knowledge of the physical and mechanical properties of these materials, to obtain maximum productivity.

INDUSTRIAL ENGINEERING GROUP

Network Management Techniques

Prof. B. S. Rao

Associate Member

Network management techniques which were developed during the late fifties, have been used for planning, scheduling, controlling or monitoring complex projects comprising a number of events and acitivities. This paper describes a few of the standard techniques of network management, *e.g.*, the critical path method (CPM), programme evaluation and review technique (PERT), and resource allocation and multi-project scheduling (RAMPS). It is mentioned that these network techniques can be applied not only to construction projects but to any activity which requires careful planning and scheduling of resources. Perhaps the limitation of the availability of computer facilities may restrict their uses in India but projects involving 200 or 300 activities can be analyzed by hand, thereby deriving considerable advantage in the implementation of the national projects.

ELECTRONICS AND TELECOMMUNICATION ENGINEERING DIVISION

One Amplifier Simulation of Third Order Systems

G. K. Aggarwal

Non-member

This paper gives a set of six tables which are found to be useful in synthesizing various forms of third order linear transfer functions, using a chain of inverted L-sections of passive resistor-capacitor elements in conjunction with a single operational amplifier. The actual procedure for synthesizing such transfer functions using this technique is illustrated.

Classification of Modes in Electromagnetic Waveguides

S. K. Chatterjee

Non-member

The classification of modes in electromagnetic waveguides based on the model solutions of source-free homogeneous wave equation and the limitations of such classification are discussed. The concept of the existence of pole waves and branch-cut waves in waveguides is explained. It is shown that guided waves, surface waves and leaky waves arise as special cases of pole waves associated with the residues evaluated at the poles and the radiation field is associated with the branch-cut integration of a contour integral, in terms of which the field is expressed as a waveguide containing an exciting source.

SEMINAR ON 'THE ROLE OF THE ENGINEER IN THE FOURTH FIVE YEAR PLAN', PATNA, JANUARY-FEBRUARY 1966

As approved by the Council in February 1965, it is proposed to hold a Seminar on 'The Role of the Engineer in the Fourth Five Year Plan' concurrently with the 46th Annual Convention of the Institution at Patna in January-February 1966. A news item of this was published in the April 1965 issue of the *Bulletin* on p. 73.

An appeal by Brig. M. K. Rao (M.), Convenor of the Seminar and Chairman of the Electronics and Telecommunication Engineering Division Board, to members inviting papers is given below. The topics for discussion and the subjectwise break-up under each topic on which papers may be presented are also detailed for information.

'By bringing together the talented and experienced engineers in the country to an organised forum, opportunities will be created for a critical examination of the part engineers can play in the successful achievement of the Fourth Five Year Plan. Some valuable suggestions are expected to come out of the deliberations. The Institution of Engineers (India) can thus effectively contribute in the nation-building activities embarked upon by the leaders of our country.

Some of the important subjects for discussion at the Seminar are given below. They indicate only the scope of the discussion. The Institution will be pleased to receive papers on the subjects mentioned in the list. If any of the authors so desire, they may include new subjects or items for discussion in their papers.

They are quite free to write papers in any manner they like and there is no restriction to the length of the papers to be submitted. They are free to submit one or more papers covering any or all the subjects to be put up for discussion.'

TOPICS AND SUBJECTS SUGGESTED FOR DISCUSSION

Organization

1. Role of the engineer in long-term perspective planning based on previous experience.
2. Role of the engineer in the execution and administration of the Fourth Five Year Plan schemes.
3. Role of the engineer in ensuring efficiency and economy in the planning of projects and speed in their execution.
4. Engineering aspects of foreign collaboration in the erection of plants in the Fourth Five Year Plan and in the training of Indian personnel for their maintenance.
5. Allocation of project priorities and role of the engineer.
6. Application of techniques for estimation of costs of projects in the Fourth Five Year Plan.
7. Role of the engineer in the Fourth Five Year Plan in small scale industries.
8. Role of the engineer in the Fourth Five Year Plan in medium scale industries.
9. Role of the engineer in the Fourth Five Year Plan in large scale industries.

Management and productivity

10. Role of advisory bodies/Indian consultancy services in the planning and execution of the Fourth Five Year Plan projects.
11. The engineer as manager—requirements of middle and senior level managers for the Fourth Plan projects—technique of selection and resources for training.
12. Adaptation of new techniques of productivity for the Fourth Plan projects.
13. Role of the engineer in coordinating the efforts of village and small scale industries so as to make them complimentary to the needs of middle and large scale industries.

Resources

14. The engineer and the research scientist—scope of research in developing indigenous raw materials to replace imported ones with a view to reducing the foreign exchange element of the various projects under the Fourth Five Year Plan.
15. Material management including value analysis as applied to Fourth Five Year Plan projects.
16. Role of the engineer in the development of Indian mining resources.
17. Role of the engineer in the development of oil and natural gas resources.

18. Foreign exchange—measures for earning foreign exchange in the Fourth Plan—Indian collaboration in setting up industries for the newly emerging nations—other features for export promotion—quality control of Indian goods manufactured for export—importance of goodwill and reputation.
19. Development of original design suited to Indian environments.

Power

20. Coordination of installed power capacity to serve the Fourth Five Year Plan projects.
21. Role of the engineer in harnessing nuclear power to serve the Fourth Five Year Plan.
22. Role of the engineer in implementing river valley projects in the Fourth Five Year Plan.
23. The necessity for developing small scale power units to serve remote regions not covered by the National or Regional Power Grids—promotion of village and small scale industries oriented to the Fourth Five Year Plan.

Development projects

24. Role of the engineer in the Fourth Five Year Plan in community development.
25. Role of the engineer in rural and urban housing and town planning.
26. Reclamation of land for housing and industry to relieve congestion in highly industrialized areas in the country.

Agriculture

27. Role of the engineer in meeting food targets of the Fourth Five Year Plan : (i) reclamation of land for agriculture; (ii) designing and production of agricultural machinery to suit Indian conditions; and (iii) provision of water for farming—sinking of tube-wells—low cost pumps for farmers.

Miscellaneous

28. Standards as applied to Fourth Five Year Plan projects.
29. Instrumentation, data processing and statistics as applied to Fourth Five Year Plan projects.

Authors are requested to send two copies of the abstracts of their papers in advance—one copy to the Secretary, The Institution of Engineers (India), 8 Gokhale Road, Calcutta 20, and the other copy to Brig. M. K. Rao, Headquarters Southern Command, Poona 1. A similar procedure should be followed while sending the full texts of papers also, *i.e.*, one copy of the paper should be sent to the Secretary of the Institution, and the other copy to Brig. M. K. Rao. Those who cannot spare time to submit full papers are requested to send a statement of views on the several points detailed in the list and also new points, if any.

The last date for receiving manuscripts of papers and abstracts is **December 1, 1965.**'

(Sd.) **Brig. M. K. Rao**

Convenor of the Seminar

PANELS FOR STUDY OF SUBJECTS OF COMMON INTEREST TO MORE THAN ONE ENGINEERING DIVISION

'Modern technology is developing so fast that it is extremely difficult to keep pace with it, specially, for those who are not in the academic line. The barriers between science and engineering on the one hand and the barriers between different disciplines in engineering on the other are continually dropping, while many of the old ones are becoming obsolete'.

Arising out of a suggestion made on these lines by Prof. N. S. Govinda Rao, President of the Institution, the Council approved the formation of the following Panels, at its 440th meeting held in Lucknow on February 23, 1965. The Panels themselves were formed at the 441st meeting of the Council held in Bhubaneswar on May 2, 1965. These Panels have been formed in order (i) to keep members of the Institution informed of the developments in certain fields, (ii) to make an intensive study of the subjects covered by each of them, leading to review articles or monographs by the Panels in due course, and (iii) to indicate new areas of research.

The Panels will pursue their studies, for the present, by correspondence only and each of the Panels will hold a meeting at the time of the 46th Annual Convention to be held in Patna in January-February 1966. Consultations between members of each Panel will be carried on directly between themselves. Reports of progress will be placed by the Convenors of the different Panels before the Council at each of its meetings.

A note on the scope of study of the different Panels and the list of members comprising the Panels are given below.

1. Materials Technology

Scope of study

Advances in the technology of materials have led from the use of materials as to take full advantage of their natural characteristics to the evolution of new materials for pre-designs. Emphasis has shifted to the formation and preparation of new materials to suit new requirements. The field of study may include metals and materials forming processes, effect of pressure and temperature on properties of materials, mechanical pressure elements, atomic structure arrangements, structural imperfections, semi-conductors, rubbers, plastics, etc.

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Shri G. S. Ramaswamy, M.I.E.,
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Structural Engineering Research Centre,
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2. Engineering Mechanics (Solids)

Scope of study

The subject envisaged for study in this Panel are such as applied elasticity, plasticity, dynamics, vibration, aero-elasticity, rheology, and allied subjects.

Members

Prof. A. Lakshmanaswamy, M.I.E. (*Convenor—Council Member*),
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Dr. Jai Krishna, M.I.E.,
Associate Professor of Civil Engineering,
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Shri G. D. Joglekar (*Non-member*),
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3. Applied Mechanics (Fluids)

Scope of study

Subjects for investigation are hydrodynamics, turbulence, boundary layers, thermodynamics, heat transfer, magneto-hydrodynamics, cavitation, and such allied subjects.

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4. Instrumentation and Automation

Scope of study

This Panel will be concerned generally with industrial instruments commonly used for remote reading or remote automatic action within the industrial plant, and such elements as are essential for this purpose. It will study the types of instruments available for the measurement and control of process variables, and the approaches used in the solution of problems common to the instrument industry. It will also deal with the purpose and future of automation, and the factors affecting the speed with which automation is likely to spread in the different parts of the world, with particular reference to this country. In the latter connection, problems will arise such as whether automation will be economical, what its ultimate effects will be on the lives of the people, and so on.

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5. New Sources of Energy

Scope of study

Subjects which may be studied are conversion of energy sources for power generation, nuclear energy and its application to peaceful uses such as excavation of canals, tracing of groundwater movement, etc., solar energy applications, direct conversion of energy to electrical power, oil and natural gas, wind and tidal power, and such allied subjects.

Members

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Calcutta 32

Dr. C. V. S. Ratnam, M.I.E.,
Superintendent (Briquetting and Carbonization),
Neyveli Lignite Corporation,
Neyveli,
District South Arcot

Shri S. Swayambu, M.I.E.,
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19A Lytton Road,
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Dr. R. N. Datta (*Non-member*),
Assistant Director (Solar Energy),
Central Salt and Marine Chemicals Research Institute,
Bhavnagar

Dr. M. G. Krishna (*Non-member*),
Director,
Indian Institute of Petroleum,
Dehra Dun

6. Space Technology and Propulsion Engineering

Scope of study

This Panel will study the problems and techniques unique in the design of spacecraft and missiles as well as of all high performance aircraft. The coverage would include subjects such as rockets, satellites, space stations, spaceships, architecture of the universe, human factors in space flying, communications in space, the trip to the Moon and to Mars, and intersteller flight. Essential factors in design such as loads, space environment, materials, thermodynamics, aerodynamics, reliability, etc. may be integrated. Other problems may range from the chemistry of propellants, tracking, vehicle design and support equipment to the training programme and personnel requirement.

Members

Prof. S. P. Chakravarti, M.I.E. (*Convenor—Council Member*),
93 Mall Road,
Mahatma Gandhi Marg,
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Capt. H. M. Goyal, A.M.I.E.,
Secretary, Joint Communications Electronics Committee,
Cabinet Secretariat (Military Wing),
New Delhi

Wing Commander R. C. Jain, A.M.I.E.,
Directorate of Guided Weapons,
Air Headquarters, Vayu Bhavan,
New Delhi 11

Wing Commander C. M. Sethna, A.M.I.E.,
Directorate of Guided Weapons,
Air Headquarters, Vayu Bhavan,
New Delhi 11

The Director,
National Aeronautical Laboratory,
Bangalore

7. Management and Materials Handling

Scope of study

Successful materials handling is today one of management's most important functions. The movement of materials is recognized as one of the most important determinants of modern production. Production is not only increased by improved methods of handling but production costs are substantially reduced. This cost-saving aspect of materials handling makes it one of the most important tools of the production manager, and in the face of rising material and labour costs, it is an important way of holding production cost in check. Very little is taught about this subject at present at any stage of technical education. Study may be initiated in this subject with special reference to Indian materials and labour conditions.

Members

Shri S. Padhi, M.I.E. (*Convenor—Council Member*),
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Shri R. M. Patri, M.I.E.,
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183/184 Rashtrapathi Road,
Secunderabad

Shri T. S. Vedagiri, M.I.E.,
Chief Industrial Engineer,
Bhilai Steel Plant,
Bhilai

Shri C. S. Chowdhury (*Non-member*),
Director,
Regional Research Laboratory,
Bhubaneswar

8. Bio-engineering

Scope of study

Bio-engineering interests cover all forms of engineering (electrical, mechanical, etc.), all forms of life sciences (pure biology to clinical medicine), and include some phases of mathematics and physics. The area of relationship between engineering and the life sciences has been called bio-medical engineering or bio-engineering or life sciences engineering, and includes such widely different subjects as bionics, applied bio-physics and medical electronics. Many of the life sciences which have in the past been primarily qualitative and descriptive in nature are now moving toward quantification, and to this rapid change engineering is contributing significantly. In the U.S.A., graduate degree courses have been initiated in bio-engineering, and references may be made to the courses at the University of Rochester, Rochester, New York, and the Oregon Regional Primate Research Centre, Beaverton, Oregon.

Members

Shri J. G. Bodhe, M.I.E. (*Convenor—Council Member*),
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Dorr Oliver (India), Ltd.,
The International,
16 Queens Road Estate,
Bombay 1

Dr. P. M. Bhargava (*Non-member*),
Regional Research Laboratory,
Hyderabad

9. Planning for Technical Development

Scope of study

Present planning is economic planning, and it is necessary that other approaches to planning are studied. Planning should be studied as a science, and discussion on the art and science of planning in its varied aspects will reveal much that is yet unappreciated.

Members

Shri K. K. Nambiar, M.I.E. (*Convenor—Council Member*),
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Poona

Dr. K. S. Chari (*Non-member*),
Deputy Director-in-Charge,
Central Design and Engineering Unit,
New Delhi

10. Consultancy and Contracts

Scope of study

Consultancy should play an ever increasing role in Indian economy and industry. But the services thus rendered are but poorly understood in this country. The Panel may study the major factors relating to the practice of consulting engineering for Indian conditions, including the functions of the consulting engineer in relation to his clients and others. The Panel may also critically examine contracts for engineering construction and other purposes. One of the aims should be to rationalize ideas and to relate them with the fields of knowledge and experience, and to show why things have to be thus and so. As contracts underlie engineering business, the study should emphasize to the engineer that a rigid framework of legal principles exist for all types of diverse constructions.

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Ajmeri Gate Extension,
New Delhi

Shri Baldev Singh,
I. L. & E.O.,
Council of Scientific and Industrial Research,
New Delhi

11. Water Resources Development

Scope of study

Water resources development includes many diversified fields such as engineering, geography, public administration and economics. The study may clarify some of the complex problems involved and suggest adequate bases for analyses. Discussions are often confused by preconceptions and emotions, and careful and dispassionate assessment and analyses are very necessary. Efficiency in the development of national water resources means efficient use of public funds. The nature and forms of development, and the purposes to be met with by development, as also the alternative policies that may be applied and their differences in costs and gains, may be studied. Conditions for achieving economic efficiency, efficiency levels which can be logically aimed at within our institutional environment, and problems of water and nature conservation are all pertinent to the study.

Members

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Hyderabad

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Pallipalayam,
Salem, Madras State

Dr. Harinarain,
Director,
National Geophysical Research Institute,
Hyderabad

12. Town Planning

Scope of study

Town planning should integrate physical planning with sociology and economics, and create a synthesis of survey plan and practice. The art of town planning should be combined with the science of civics to achieve essential harmony. The study may show, with concrete arguments and local instances, how these separated aspects could be brought together, making use of the elements of a civil uplift available to us. Beyond the general improvements which are attempted to be made and which are more or less common to all cities and towns today, newer approaches may be studied and indicated for developments in the future and for human and social regeneration in the particular circumstances of Indian life and conditions.

Members

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Ahmedabad 6

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Shri S. Rajagopalan, M.I.E.,
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Directorate General of Health Services,
D2 Flat 9 North of Medical Enclave, New Delhi 3

13. Biographies of Eminent Engineers in India

Scope of study

The names of some automatically suggest themselves. Examples are Sir Rajendra Nath Mookerjee, Sir Ganga Ram and Nawab Zain Yar Jung Bahadur. The Panel may also go further back in history and collect material on the lives of those who were responsible for the design and building of India's many outstanding structures which have resisted the ravages of time and are still standing in majestic testimony of their architects. These studies may lead to the preparation of small books or brochures for study in the schools and to inspire the younger generations.

Members

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Shri B. Seshadri, M.I.E.,
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14. Public Relations, Publicity and Representation of Institution on Technical and other bodies

Scope of study

This Panel will study the scope of present-day public relations practice as applicable to the Institution and the engineering profession. Public relations is an essential function of the management of the Institution, as service in the public interest is the ultimate criterion by which the Institution and its policies will be judged. Ethical standards and technical skills will broadly represent the two prongs of the Institution's progress. Public relations for the Institution implies the provision of promotional information on its objectives and the creation of a receptive environment in the public mind for its activities. One of the objects for which the Institution was constituted is cooperation with other technical bodies for the furtherance of the science of engineering. It is, therefore, represented on many such bodies, and efforts have to be made so that it is represented on many others also.

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C/o Allahabad Polytechnic,
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The Honorary Secretary,
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Jammu Sub-Centre,
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Prof. P. Banerjee, A.M.I.E.,
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Shri Dinesh Mohan, M.I.E.,
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Roorkee Sub-Centre,
C/o University of Roorkee,
Roorkee

Dr. A. K. Das Gupta, M.I.E.,
Honorary Secretary,
The Institution of Engineers (India),
Rourkela Sub-Centre,
C/o Department of Electrical Engineering,
Regional Engineering College,
Rourkela 8

15. Statistical Techniques in Management

Scope of study

Statistical techniques have an important part to play in the practice of management. The application of these techniques to the field of quality control has become one of the leading advances in industrial technology. Essentially, statistical quality control regulates the quality of materials, parts, products and processes by scientific techniques of sampling, inspection, analyses of results, and charting devices. The study may extend to the freeing of quality control from empiricism, reduction in inspection and manufacturing costs, acceptable quality levels, forecasting of sales patterns, charting of financial and operating ratios for management, personnel placement and evaluation, and even clerical operations. Further, the application of statistical techniques to particular industries of special importance to Indian conditions may be studied.

Members

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Headquarters, Southern Command,
B.E.M.E. Office, Southern Command,
Poona 1

Prof. S. K. Ekambaram (*Non-member*),
Administrative Staff College of India,
Hyderabad

Shri F. H. Hakade (*Non-member*),
International Computers and Tabulators (India) (P) Ltd.,
Poona

16. Safety in Engineering

Scope of study

Safety in engineering includes a combination of the allowances necessary to be made in the use of practical data, including an allowance for the lack of precision with which certain conditions can be ascertained. If the usage and care to which a product or a structure or an equipment would be put could be specified, then safety in engineering would be a simple matter. Safety factors in engineering, nevertheless, have a rational basis which become more apparent as the conditions which govern the factor become known. Besides these, there is safety in operational and maintenance procedures, in prevention of accidents, in inspection methods, and indeed in every phase of engineering activity. One or more aspects of selected subjects may be studied.

Members

Maj.-Gen. R. A. Loomba, M.I.E. (*Convenor—Council Member*),
Director General of Works,
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9 Shankarnagar,
West High Court Road,
Nagpur 1

17. Standards in Engineering

Scope of study

The work of this Panel will not consist in the preparation of engineering standards, but in the study of avenues in which standardization may be attempted or explored with resultant benefits to engineering practice. There are many such in which standards are yet unwritten. Not the least of these would be standard of conduct, ethical standards, educational standards, training standards, and such others, pertaining to engineering. As the precise meaning of 'standard' may only be judged from its context, the term has wide application, from the popular concept, implying the relative kind and quantity of consumer goods to the social science application to have supplementary concepts.

Members

Shri B. P. Kapadia, M.I.E. (*Convenor—Council Member*),
Consultant,
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Dr. Lal C. Verman, M.I.E.,
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Shri T. A. Rao, M.I.E.,
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Railway Testing and Research Centre,
Alambagh,
Lucknow

INSTITUTION NOTICES

Draft Indian Standards

Draft Indian Standard Specification for Crane Rail Sections—Doc : SMDC 6 (578).

This Standard lays down the dimensions, shape and other requirements of crane rail sections.

Members may send their comments on the above standard before November 1, 1965, to Shri T. R. Mehandru (*M.*), 14 Asaf Ali Road, Ajmeri Gate Extension, New Delhi, who is the Institution representative on the Sectional Committee dealing with this Standard.

Draft Indian Standard Code of Practice for Noise Reduction in Industrial Buildings—Doc. BDC 12 (836).

This Standard covers the types and sources of industrial noise and the acceptable limits of noise lends in factories, machine shops and other industrial buildings and recommends the required noise reduction measures.

Members may send their comments on the above draft Standard before November 5, 1965, to Shri H. P. Sinha (M.), Consulting Engineer, Road Development and Joint Secretary, Ministry of Transport, Jamnagar House, Shahjahan Road, New Delhi, who is the Institution representative on the Sectional Committee dealing with this Standard, and a copy to Shri R. M. Patri (*M.*), Chairman, Industrial Engineering Group, Modi Mansion, 183/184 Rashtrapathi Road, Secunderabad.

Copies of the draft Standards may be obtained from the office of the Indian Standard Institution, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 1, or from its branch offices at 232 Dr. Dadabhoy Naoroji Road, Bombay 1 ; 11 Sooterkin Street, 3rd Floor, Calcutta 13; 14/69 Civil Lines, Kanpur; or 1/12 First Line Beach, Madras 1.

LOCAL CENTRE ACTIVITIES

Uttar Pradesh Centre

The Uttar Pradesh Centre of the Institution is organising a Seminar to be held on December 11 and 12, 1965 at Lucknow. The subjects to be discussed at the Seminar are :

1. Substitute for cement as a building material
2. Cracks in concrete and preventive measures

Members who desire to contribute papers may send their papers to the Organising Secretary, The Institution of Engineers (India), Uttar Pradesh Centre, River Bank Colony, Lucknow, on or before October 31, 1965.

FORTHCOMING CONFERENCES

Giorante del Precompresso, Ravello, October 4-5, 1965

The Italian Member Group (ANICAP) of the Federation Internationale de la Precontrainte (FIP) is organising two-day meetings at Ravello, near Naples, Italy, on October 4 and 5, 1965. On Monday, October 4, 1965, there will be a report and discussion on 'Limit States—Bending and Shear Force' and on Tuesday, October 5, 1965, on 'Behaviour of Prestressed Concrete Structures with Time—Experimental Results and Specifications'. There will also be a lecture on 'Construction Systems Using Cantilevering'.

Further details can be obtained from ANICAP, Via Eudossiana 18, Rome, Italy.

Diamond Jubilee of the Bombay Electric Supply and Transport Undertaking, Bombay, November 1965

The Bombay Electric Supply and Transport Undertaking completes 60 years of its electric supply service in September 1965, and to celebrate its Diamond Jubilee, a series of lecture meetings and symposia on the following topics have been planned to be held in November 1965: (i) Role of electricity in transport, (ii) Role of electricity in industry, (iii) Electricity in homes, (iv) Problems of distribution of electricity in metropolitan cities, (v) Safety in the use of electricity, (vi) Training of personnel for electric supply industry, and (vii) Public utility services in the public sector.

Further details can be obtained from the Public Relations Officer, Bombay Electric Supply and Transport Undertaking, BEST House, P.O. Box 192, Bombay 1.

CORRIGENDUM

TO VOL. 14, NO. 11, JULY 1965

Page 34, instead of '61 B Anoo Raghavendra Rao', please read '61 B Anoo Ragevandra Rao Rama Rao'.

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, industrial and other organisations employing engineers. It is hoped that the employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

SITUATIONS WANTED

JIG AND TOOL DESIGN Trainee, aged 25, passed L.M.E., in high First Class, passed Section A of the Associate Membership Examination of the Institution of Engineers (India) in the first attempt, will be completing a two-solid year specialized training in die and tool design at Technical Training Centre attached to Small Scale Industrial Units, Madras, by the end of December 31, 1965. Well trained in design and drawing, press tools, jig and fixtures, gauges for workshop use and pressure die-casting dies, etc. Available for suitable employment from January either in Design or Production line in any leading manufacturing concern. Employment in South India preferred. Salary expected is Rs. 325 per month. (Office ref. E.S. 205)

THE COUNCIL 1965-66

President

Prof. N. S. Govinda Rao

Past-Presidents

Dr. T. Sen

Maj.-Gen. Harkirat Singh

Chairmen of Local Centres

V. Pravathesam (*Andhra Pradesh*)
K. Mazumdar (*Assam*)
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S. N. Sinha (*Bihar*)
D. R. Bhise (*Bombay*)
Maj.-Gen. R. A. Loomba (*Delhi*)
G. S. Desai (*Gujarat*)
H. K. Gandotra (*Jammu & Kashmir*)
T. P. Kuttiammu (*Kerala*)

M. Y. Koli (*Madhya Pradesh*)
N. G. Mahalingam (*Madras*)
R. A. Rajagopal (*Mysore*)
R. M. Tarkunde (*Nagpur*)
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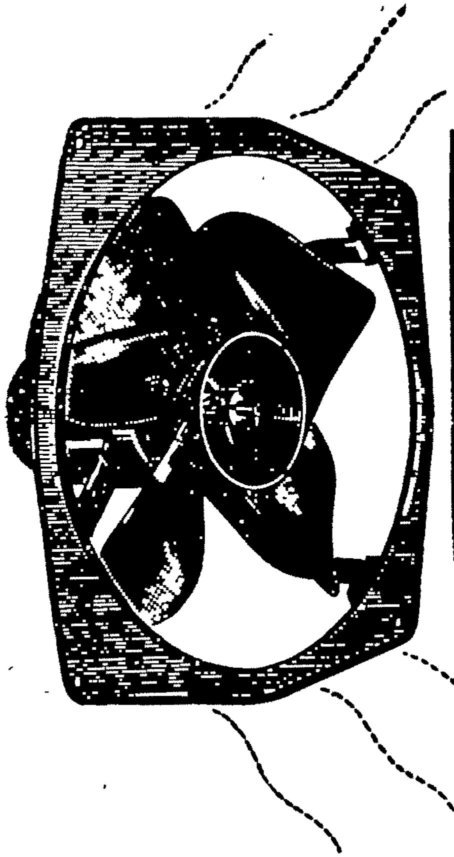

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FORTY-SIXTH ANNUAL GENERAL MEETING
PATNA, BIHAR
JANUARY 29-FEBRUARY 5, 1966

The 46th Annual Convention will take place in Patna from January 29 to February 5, 1966. The Convention will be inaugurated at 9.00 a.m. on Sunday, January 30, 1966.

The programme will include, besides Paper Meetings in the various Division and Groups, a Seminar on 'The Role of the Engineer in the Fourth Five Year Plan', information on which has already been circulated in the *Bulletin* dated September 1965.

Attention is particularly invited to the fact that rail concession has been withdrawn by the Railway Board due to the National Emergency, but efforts are being made to secure the concession. A request has been made to the Railway Board again this time for a resumption of the rail concession to delegates attending this Convention at Patna, and the reply will be communicated to members in time through the *Bulletin*. The tentative programme is given below for information.

Details of the Convention programme as well as hotel accommodation to delegates, registration, acceptance forms, etc. are being finalized by the Bihar Centre and will be announced in the next issue of the *Bulletin*.

CONVENTION PROGRAMME (TENTATIVE)

Saturday, January 29, 1966

8.30 a.m. to 1.00 p.m. 2.00 p.m. to 4.00 p.m.	Registration of local and outstation members and visitors attending the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan'
9.30 a.m. to 11.45 a.m.	First Session of the Seminar
11.45 a.m. to 12.00 noon	Coffee
12.00 noon to 1.00 p.m.	Second Session of the Seminar
1.00 p.m. to 2.00 p.m.	Lunch
2.00 p.m.	Meeting of the Indian National Committee for the World Power Conference
2.30 p.m. to 3.00 p.m.	Adjourned Meeting of the 1964-65 Council
3.30 p.m. to 4.30 p.m.	Business Session of 46th Annual General Meeting
4.30 p.m. to 5.00 p.m.	Tea
5.30 p.m.	A Talk on 'Bio-Engineering' by Shri J. G. Bodhe, Member of Council

Sunday, January 30, 1966

9.00 a.m. to 1.00 p.m. 2.00 p.m. to 4.00 p.m.	Registration of local and outstation members and visitors (continued)
9.00 a.m. to 11.45 a.m.	Inauguration of the 46th Annual General Meeting
11.45 a.m. to 12.00 noon	Coffee
12.00 noon to 1.00 p.m.	The Ninth Sir Mokshagundam Visvesvaraya Lecture by Dr. T. Sen, Past-President
1.00 p.m. to 2.00 p.m.	Lunch
2.30 p.m. to 4.30 p.m.	Inauguration of the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan'
	Third Session of the Seminar
4.30 p.m. to 5.30 p.m.	'At Home'
7.30 p.m. to 9.00 p.m.	Annual Dinner
9.00 p.m. to 11.00 p.m.	Variety Entertainment

Monday, January 31, 1966

9.00 a.m. to 11.45 a.m.	Fourth and Final Session of the Seminar
11.45 a.m. to 12.00 noon	Coffee
12.00 noon to 1.00 p.m.	Address by Division/Group Chairmen and Paper Meetings in the Public Health Engineering Division; Prestressed Concrete Group; Shell Structures Group; Mechanical Engineering Division; Industrial Engineering Group; Aeronautical Engineering Group; Chemical Engineering Division; Electronics and Telecommunication Engineering Division; and Automatic Control Group
	Seminar (to be continued as necessary)
1.00 p.m. to 2.00 p.m.	Lunch
2.30 p.m. to 4.00 p.m.	Paper Meetings (to be continued as necessary)
	Seminar (to be continued as necessary)
4.00 p.m. to 4.30 p.m.	'At Home'
4.30 p.m. to 8.00 p.m.	Students' Session—(1) General, and (2) Technical*

*** Students desirous of presenting papers at this Session should send their manuscripts to the Headquarters Office at Calcutta not later than Friday, December 31, 1965.**

4.45 p.m.	Visit to Rajgir by special train (for delegates not participating in Outstation Tours). Bath in Sulphur Springs at 7.30 p.m. Dinner at 8.30 p.m. and rest in train or Rest House

Tuesday, February 1, 1966

6.30 a.m.	Leave Rajgir for Nalanda (visit to last for nearly 2 hours). Leave for Patna by special train
9.00 a.m. to 10.30 p.m.	Meetings of Panels for Study of Engineering Subjects of Common Interest
10.30 a.m. to 11.00 a.m.	Meetings of the Division Boards
11.00 a.m. to 1.00 p.m.	Address by Division/Group Chairmen and Paper Meetings in the Civil; Engineering Division; Roads and Road Transportation Group; Railway Engineering Group; Mining and Metallurgy Division; Petroleum Engineering Group; Electrical Engineering Division; Nuclear Engineering Group and; Marine Engineering and Shipbuilding Group
1.00 p.m. to 2.00 p.m.	Lunch
2.00 p.m. to 4.30 p.m.	Paper Meetings (to be continued as necessary)
4.30 p.m. to 5.30 p.m.	'At Home'
6.00 p.m. to 8.00 p.m.	Variety Entertainment

Wednesday, February 2, 1966

9.00 a.m. to 10.00 a.m.	Meeting of the Engineering Education and Research Committee
9.00 a.m. to 12.00 noon	Paper Meetings (to be continued as necessary)
	Seminar (to be continued as necessary)
12.00 noon to 1.00 p.m.	Closing Session of the 46th Annual General Meeting
1.00 p.m. to 2.00 p.m.	Lunch
3.00 p.m. to 3.30 p.m.	Meeting of the 1965-66 Council
3.30 p.m. to 5.00 p.m.	Local Visits for delegates participating in Outstation Tours
7.00 p.m. to 10.00 p.m.	Commencement of Outstation Tours

Thursday, February 3, 1966	
9.00 a.m. to 1.00 p.m.	Local Visits for delegates not participating in Outstation Tours
Friday, February 4, 1966	Outstation Tours in progress
Saturday, February 5, 1966	Conclusion of Outstation Tours and dispersal

CONSTRUCTION INDUSTRY IN THE U.S.A.

Mahesh Varma
Associate Member

Introduction

Construction is the largest industry in dollar volume in the U.S.A. In 1963, the new constructions amounted to $62.5 billion and maintenance and repair works to $21.3 billion, thus making a total $83.8 billion for the industry. Agriculture came next with $ 36.2 billion. The three years, from 1963 to 1965, have sown an expansion of over 25% in the total annual heavy construction contracts, the highest steady rise in business since expansion started after the Second World War.

The *Engineering News Record* figures for the actual cost of construction in 48 States (except Alaska and Hawaii) for the three years are given in Table 1. These figures do not include projects costing less than $100,000 for industrial buildings and less than $500,000 for other buildings. The costs of one- and two-family houses are also excluded.

Table 1

Cost of Construction data

Year	Cost of construction, millions of dollars	Percentage rise
1963	23,116	—
1964	25,947	12
1965	27,660	7

These figures indicate that the industry is passing through a period of 'boom'. Almost one-half of the total cost of construction during 1964 was accounted for by only 9 of the 48 states, *viz.*, California, New York, Texas, Ohio, Pennsylvania, Illinois, Florida, Michigan and New Jersy.

Contract system of construction

Practically the entire volume of construction in the country, both private and public, is accompolished through contracts. Public agencies like the U.S. Bureau of Reclamation, the U.S. Corps of Engineers and the Bureau of Public Roads have declared the contract system as their established policy and over 95% of all public works are done in this way.

However, the ease of entry into contracting business has resulted in a high degree of overcrowding in the field of construction. The want of adequate skill in the business and the associated high risk and slim margin of profit usually result in many business failures which have shown an upward trend during the past. During 1961, construction contract failures constituted 16.1% of the total business failures, while in 1964, this figure increased to 17.7%. The liabilities resulting from these failures have shown an increase from $190 million in 1960 to $262 million in 1964.

All is not well, therefore, with this top-ranking industry of the nation although record new plans are coming up for bids; there are good prospects for federal contracts and sufficient funds seem to be available for long and short term financing.

Construction—a complicated business

The large number of failures in construction business in the country may be principally attributed to the complicated nature of contracting business under the present economic and industrial pattern. Adequate key personnel, management financing, bank and surety company credit and technical proficiency in the construction field constitute the important aspects of this business. As the size of the undertaking increases, the economic and managerial considerations far outweigh the attention to field operations. A knowledge of general industrial development, property management, cost accounting, legal and insurance matters, fiscal and taxation status, etc. is absolutely necessary. Recent management techniques like C.P.M. and computer applications are more and more in use and there is a better understanding of programming, cost accounting and scheduling. Even for an average contractor, cost accounting constitutes an important aspect of the business, as it helps him not ony to maintain cost control and locate faulty spots in the work, but it also furnishes useful and dependable information for preparing future bids. Insurance, taxation and labour relations invariably call for professional help of specialists. Constantly increasing competition necessitates use of the latest methods in construction technique.

It may be mentioned here that the urgency of placing the profession of a constructor on sound foundations is being recognized every day. Construction is considered as a field of engineering in its own right and several reputed institutions of the country have introduced construction education at undergraduate and post-graduate levels, awarding Bachelor's, Master's and Doctor's degree in this field. Professional societies have formed and a number of excellent magazines are published, exclusively devoted to the field of construction.

Types of contract

There are two major types of contracts prevalent in the country, *viz.*, competitive bid contracts and negotiated contracts, the first being more common. Public contracts are almost all let on the basis of competitive bids. Contracts are further classified as unit price and lumpsum contracts. The cost-plus contract is another important form of contract belonging to the negotiated class. When the nature of construction is such that it is not possible or practicable to supply complete information about the work in the form of drawings and specifications before the work is commenced, this form of contract is used. An underpinning operation may belong to this class. Under this form of contract, the owner undertakes to pay the contractor all the costs actually incurred by him in the execution of the work plus a compensation for his services according to some agreed plan, such as a fixed sum of money or a percentage of the cost of the work. Some special types of contracts include the combined cost of architect-engineer's services and construction and management contracts. In the first one, the contractor also functions as the architect-engineer, while in the second, he is also responsible to manage the work on behalf of the owner, the entire or substantial part of the work being sub-contracted.

Responsibilities of contractor and architect-engineer

The prime contractor is responsible for completing the work within the time and in the manner as prescribed in the contract documents. The responsibility to ensure adherence to legal requirements concerning job safety, licencing, sanitation, labour, employment, insurance, etc. also rest on him and he is liable for damages resulting from injury to any person or property caused in the process of execution of work. He must, therefore, of necessity carry adequate insurance and ensure that his sub-contractors also do the same. The prime contractor is entirely responsible for the quality of workmanship of his sub-contractors.

Most of the owners who award contracts do not employ whole time planning and designing staff, but engage the services of a licenced professional architect or engineer to do this work and formulate contract documents. The architect is engaged if the work pertains to construction of buildings and the engineer if the work involves heavy construction such as highways, earth structures, industrial projects, etc. The architect-engineer is, thus, the principal agent of the owner who prepares plans and specifications and maintains the necessary field vigilence to ensure requisite quality of work. The reputation of the architect-engineer for fairness and integrity naturally affects the nature of the bids as considerable authority is vested in him by contract documents. Public work smay also engage the services of architect-engineers. On Federal works, the contracting officer performs the functions of the architect-engineer.

The architect-engineer is responsible to approve the contractor for the award of the contract and also approve his sub-contractors. He has the right to interpret his documents and to exercise overall supervision or the execution of the work and approve all materials which are to be used on the construction. He may, in the interest of safeguarding the quality of the work, order construction work to be halted or remedied and he issues certificates for payments for work, both progressive and final.

The architect-engineer is responsible to the owner for the adequacy of the contract documents and soundness of the design.

Sub-contracting

A practice which is solidly entrenched in the construction business and is on the increase is that of sub-contracting considerable portions of work by the prime contractor to other smaller contractors or speciality contractors. A recent survey made by the Associated General Contractors of America showed that sub-contracting appears to be more popular with small contractors ($3 million and under), while the trend with larger ones is to utilize their own force. In spite of the difficulties associated with sub-contracting of large proportions of work such as the difficulties in proper scheduling of job operations, coordination of activities, communication between management and workmen, etc., there is a definite trend for sub-contracting. The restrictions on sub-contracting as imposed by certain public agencies are being liberalized and in some cases, as much as 90% of the total work is permitted to be sub-contracted. On public works, bidders are required to submit the names of their sub-contractors within 48 hours of submission of the bids.

Sub-contracting enables the prime contractor to dispense with the necessity of maintaining an expensive full-time organization of skilled technicians, while he is able to call for the services of these people by entrusting the work to a sub-contractor who is able to afford full-time employment to his crew. Thus, the practice of sub-contracting permits economical use of available labour forces.

The Miller Act protects the payments due to the sub-contractor or the material suppliers from the prime contractor and all Federal works require the contractor to furnish a payment bond in conformity with this Act. In the matter of awarding sub-contracts, the general contractor may sometimes be tempted to indulge in un-ethical practices of bargaining after the bids have been received, known as 'bid-shopping' or 'bid-chiselling'. The necessity to safeguard the interests of sub-contractors under such situations has attracted the notice of legislators and several States have enacted legislative measures in this regard.

Contractor qualifications

Construction contracting in the U.S.A. is a business which is on the verge of overcrowding and is subject to keen competition. It is, therefore, necessary for the owner to screen out the incapable and overextended bidders, even though such contractors might become the lowest bidders.

Many States in the contry require licencing of the contractor before he is permitted to bid for any work in the State. The licences are issued on consideration of such facts as qualifications and business experience, record of previous work completed, financial standing, general reputation, etc., and in some cases upon the passing of prescribed tests. A licencing fee is always required. The licences are issued in classes depending upon the annual volume of business or the maximum size of the contract for which the contractor is considered eligible. The licencing condition also applies to sub-contractors.

Bonding

Perhaps the most effective screening of contractors is done through the institution of bonding for contracts and all public and many private works require the bidder to furnish the requisite bond with his bid. The contract bond is a guarantee furnished by the surety bonding company on behalf of the contractor, stating that the contractor will execute his contract in accordance with the contract documents and deliver the work to the owner free and clear of any liens and encumberances. The surety company, thus, undertakes to compensate the owner in the event of any default, debt or mismanagement by the contractor. The surety company, therefore, thoroughly evaluates the status of the contractor and only upon full satisfaction issues the necessary bond. It acts like a 'sieve' to separate the incompetent contractors from others considered suitable for the job. A contract bond is not an assurance against failures, but a proof of the contractors' status and eligibility for a contract The evaluation by the bonding company involves an examination of the contractor's financial position, his experience, integrity, existing volume of work, band credit and general reputation.

In addition to the above, public projects require a statement of the contractor's pre-qualification prior to bidding. The statement includes information about contractor's experience, finance, equipment, personnel, jobs current and references. The contractor is allowed to bid only when the agency calling bids is satisfied about his capability to undertake the work after an inspection of the pre-qualification statement.

In this connection, the role of the Bureau of Contract Information, Inc., Washington D.C., needs mention. This agency collects and compiles information concerning the record of responsibility and contract performance of every general contractor in the U.S.A. and makes this information available to contract awarding authorities.

Labour unionization and contractors associations

The construction industry in the U.S.A. has lately been subject to strong forces of unionization on the part of both labour and employers, and the present trend is for greater and greater unity among the labour on the one hand and the contractors on the other. Agreements are negotiated on the basis of collective bargaining and signed mostly on regional basis. The duration is commonly for a year but longer contracts are also coming into use. An example of this is the recent no-strike, no-lock-out project labour agreement covering the 7-year construction period of the billion-dollar, 75-mile rail project to be constructed by the San Francisco Bay Area Rapid Transit District as a joint venture. At the peak of construction, the project is expected to employ 7,000 to 8,000 construction workers.

Labour Unions

Though labour union activities in the country started as early as 1840, the real impact of these on the industrial pattern of the country began to be felt during early 1930's. At the time of the New Deal era, labour union movements enjoyed unprecedented support from the Government as well as the public. Labour excesses started soon after this and it became necessary to restrict the power of the unions through legislative measures of which the Taft-Hartley Act of 1947 is perhaps the most important.

The American Federation of Labour (A.F.L.) was founded in 1886 and is now the most important union association, being a loose confederate of many sovereign national unions including those pertaining to the construction trades. The Committee for Industrial Organization (C.I.O.) was formed in 1935 and its sphere of influence mainly extends over mass production industries. The A.F.L.-C.I.O. together constitute the most powerful labour influence on the American industrial scene. There is a union for every craft and some twenty international unions (*i.e.*, for U.S.A., Canada and Mexico) have combined to form the Building and Construction Trades Department of the A.F.L.- C.I.O., and to these belong all the organized workers of the construction industry.

The wages of the construction labour are governed under collective bargaining agreements which are concluded between the unions and the contractors. These wages have shown a sharp rise during the last 20 years or so, with the result that construction costs have also shown a continuous upward trend. Added to the wage increase are the provisions of fringe benefits which include health and welfare funds, paid vacations, pension funds, paid holidays, etc. These benefits are the means of supplementing wages and are based on the hours of work put in by the workmen. The amount of fringe benefits is accummulated under a special fund which is managed jointly by the employers and the employees for the welfare of labour.

Apart from wage rise, certain unhealthy practices like 'feather-bedding' and jurisdictional disputes are also attributed to unionization of labour. In fact, the power of the unions has extended beyond the industrial field and is being felt in politics as well. For instance, the unions are said to have considerable influence during the country's elections. It has been alleged that the present bid of the A.F.L.-C.I.O. to seek elimination of section 14(b) of the Labour Management Relations Act is an attempt to harvest the return for their political efforts in Presidential elections. Under section 14(b), several States have passed right-to-work laws under which a worker is not obliged to join a union after he finds a job. Work stoppages resulting from jurisdictional controversy, or as a result of employment of non-union workers by contractors, have been fairly common in the construction industry. Jurisdictional disputes arise when a union feels that an encroachment of its traditional sphere of work has been made by some other union, and these occur quite frequently on large projects such as those under defence or space programmes, due to the controversial nature of the crafts involved. An example of this is the recent strike at Cape Kennedy and Merritt Island Launch Area in Florida where all NASA jobs came to a halt as a protest against the use of steel workers employed by Marion Power Shovel Co. in the building of crawler transporters. These are heavy machines which would transport moon rockets from the assembly building to the launch pad. This is the fifth strike of the year and involved about 3,800 workers. The union claimed that the crawler transporter job pertained to the construction workers who should have been employed and not to the steel workers. The National Joint Board for the Settlement of Jurisdictional Disputes, a non-official organization of several contractors' associations and unions, has played a useful role in the settlement of such disputes. Despite the above facts, it is certain that the unions have come to stay in the industrial pattern of the country and would probably continue to gather strength as time passed. There have been some beneficial effects of unionzation too, particularly for the construction industry. Labour which constitutes a grave element of risk in the work of the construction contractor has been stabilized and much of the uncertainty relating to the employment of labour has been removed. The contractor can call for trained personnel from the union at any time according to his needs. Another beneficial influence of the unions has been towards training of future craftsmen through apprenticeship programmes.

Contractors' organizations

The necessity to put up a front against the demands of the labour unions spurred the contractors to form associations and guard their interests. The result has been the creation of such national organizations as the Associated General Contractors of America, the National Association of Home Builders and several local contractor organizations. These local bodies strive for collaboration among contractors of a region in the use of equipment or in a combined safety programme, and most important of all, in collective bargaining with labour unions. Both local and national organizations aim at improving the standards of the contracting business and elevating it to the status of a full-fledged profession. They formulate codes of ethics for their members, publish magazines and serve as a clearing house of professional information. The recently evolved Plan Bulldozer is an example of aimed contractor collaboration in situations where heavy damage is caused by accidents during construction. Several working aids in the form of codified information and standard forms for contract documents and cost control are available to the contractor as developed by several contractor and professional organizations. Mention may be made of A.G.C.'s Contractors' Equipment Ownership Expense and Equipment Rental Agreement Form, American Association of Cost Engineers' Cost Control Code, Associated Equipment Dealers' Equipment Rental Rates, etc.

Joint ventures

An important aspect of contractor-collaboration is the joint venture system of contract which was started since the construction of the Boulder Dam. Joint venture is a partnership of firms, as distinguished from the partnership of individuals, for heavy jobs. Projects like the Boulder, Shasta and Grand Coulee have been constructed this way. Among the benefits derived from this system of working are the elimination of double taxation, mutual supplementing of abilities of parties, reduction in management personnel and spreading of risk over several jobs. Projects costing 15 to 20 million dollars have been successfully bid on this plan. Recently, the contract for the 370-ft. high rolled earth-filled 354 million dollar Mangala Dam in Pakistan was awarded on this basis. In the U.S.A., heavy projects associated with defence or space research usually call for joint ventures.

Cost trends and profit

A recent survey of contracts for the period 1958 to 1961 conducted by the Associated General Contractors of America has revealed the trend of costs nd profits in the construction industry. Investments have been rising while the margin for profit has been on the decrease. The cost invested in equipment has shown an increase of 40 to 100% during the above stated period of three years, while the net worth has shown little increase. While the returns on invested capital in some other industries are as high as 22.4% (G.M.) after tax deduction, the return on investment in the construction industry at the highest level is 7% before taxes. As with investment, the direct cost of construction involving labour, material, equipment and overheads has also shown a marked upward trend during the past few years. At the same time, competition has increased and the margin for profit has further reduced.

According to the Bureau of Public Roads, the cost index for highway construction based on a value of 100 for 1957-59 increased to 101.0 in 1963, 102.0 in 1964 and 103.8 in the last quarter of 1964. Figures for irrigation and hydro costs based on an index of 1.00 for 1949-51 changed to 1.28 in 1962, 1.30 in 1963 and 1.34 in 1964, as reported by the U.S. Bureau of Reclamation. A further study of increase in the cost of individual items is given below.

Labour

Labour seems to be the most important element of cost and risk in the work of a construction contractor in the U.S.A. The wages are constantly on the rise and A.F.L.-C.I.O. have even reiterated their goal of 35-hour week. double time for overtime and

2 dollar an hour as the minimum wage. According to *Engineering News Record* survey of construction costs of 20 representative cities of the country, the average wage index based on 100 for 1950 stood as 225 for common labour, 197 for skilled labour and 197 for equipment operators as on March 1965. It is expected that by December 1965, the common labour rates would average about 5% higher and skilled labour wages about 4% higher than those at the end of 1964.

Materials

The three important construction materials that affect the cost of construction predominantly are structural steel, cement and lumber and the *Engineering News Record* survey indicates that based on an index of 100 for 1957-59, the material cost index stood at 106 in February 1965. This indicates an average increase of about 1% every year.

Equipment

In a country where manual labour is expensive and a high degree of mechanization exists, it is natural to expect that the construction industry would employ a great deal of mechanical equipment for field operations. However, this employment introduces problems of ownership and operation, which assume increasing importance as the size of organization increases. The incidence of investment on equipment at the present time ranges from 25 to 33% of the total net worth at all levels of volume and shows an upward trend as already pointed out. Large contracting organizations are obliged to formulate a definite plan as to the use and upkeep of mechanical fleet.

Plant and equipment may be purchased by the contractor or rented from dealers or from other contractors. The practice of renting equipment is well established and saves many a small and medium class contractors from investments which his resources could hardly permit. Most of the large contractors have about 70% or more of their capital invested in capital equipment. In general, however, if an equipment is expected to be utilized for less than 6 months in a year, it is considered advantageous to rent it for work. Where the equipment is likely to be idle for considerable periods, two plans are available to the owner. He may either sell it and charge the difference in purchase price and disposal price to the work, or float a subsidiary company to take charge of the equipment and maintain, repair and lend it to other contractors or for his own works.

The cost accounting procedure involved has to be decided in conformity with the rates of depreciation as approved by the Internal Revenue Service of the Federal Government. A.G.C. survey indicated that the manner of tools and equipment accounting is primarily the same for all the contractors responding to the survey. Small tools (unit cost $200 or less) are not capitalized while the other equipment are depreciated on straight line basis.

Engineering News Record survey involving 20 representative cities showed that cost index of heavy construction equipment based on 100 of 1957-59 stood at 112 by January 1965. This shows a rise of 2% on the average every year.

Overheads

With the new management procedures in use and the improvements in organizational controls, the overheads have risen to an overall average from 4.2 to 6.2% during the period of survey. Salaries form almost one-half of the overhead costs, the rest being due to taxes, insurance and bond, rent and office supplies, etc.

Conclusions

Construction is the largest industry of the U.S.A. in respect of dollar volume. Yet the future trends do not seem to be encouraging. Construction costs have shown a steady increase during the past 15-20 years and this increase is continuing. The margin for profit which had been much smaller than for other industries is further falling, while capital investment and risks associated with it are on the rise. In view of the persisting cut-throat competition, the profits might decline substantially. The industry is therefore faced with serious problems and it is difficult to predict how long it would be able to maintain the position as the nation's top-ranking industry.

Acknowledgment

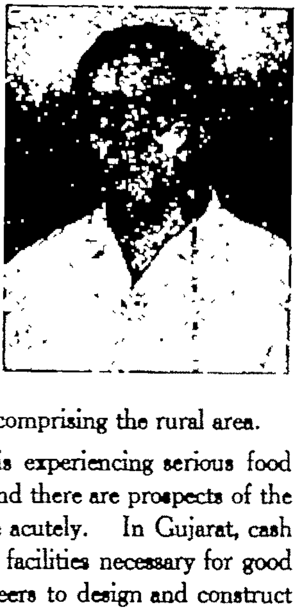
The author is grateful to Prof. E. Bidwell, of the School of Civil Engineering, Oklahoma State University, Stillwater, Oklahoma, U.S.A., for his guidance in the preparation of this paper.

ADDRESSES OF CHAIRMEN AT THE ANNUAL GENERAL MEETINGS OF THE LOCAL CENTRES

Gujarat Centre

Chairman's address by Shri G. S. Desai, B.E., M.I.E., at the 5th Annual General Meeting of the Centre on January 25, 1965

The Chairman welcomed the Chief Guest, Shri U. S. Parikh, Minister of Agriculture and Forests, Gujarat, and other invitees, and thanked the Committee of the Centre for electing him Chairman for the year 1964-65.



Delivering his address, Shri Desai said, 'This time, I prefer to discuss the scope and functions of engineers in the context of the newly created Panchayats in our State with a view to study the problem of rural regeneration. By and large, the Panchayats in conjunction with the Block Development workers, have been in charge of development of the rural areas of the State, which, of course, includes agriculture. Out of a total area of 71,055 sq. miles, 70,322 sq. miles of area will be in the charge of the Panchayats and an area of 733 sq. miles only is occupied by 181 cities and towns. Further, out of the total population of 20,633,350, nearly 15,316,726 persons (74.23%) live in rural areas and only 5,316,624 persons (25.77%) reside in urban areas. There are 18,584 villages comprising the rural area.

Our country in general, and our State in particular, is experiencing serious food shortage. Even though *kharif* crop is very good this year, and there are prospects of the *rabi* crop being good, people are experiencing food shortage acutely. In Gujarat, cash crop absorbs about 53% of cultivable land. Assuming the facilities necessary for good agricultural production, it will be the function of the engineers to design and construct roads, major and minor irrigation schemes, and electric power stations and transmission lines, as these will have direct bearing on the efficient production and distribution of foodgrains.

It is estimated that on an average, in our country, 25% of the villages lie 3 to 5 miles away and more than 36% of the villages lie 6 miles and more away from metalled roads. As far as Gujarat is concerned, the position is still worse; it ranks 13th as far as the mileage of roads per lakh of population is concerned. When the whole country has attained the Nagpur Plan target, Gujarat will be 30% behind the target. According to the 1961-81 Road Development Plan, the total road mileage of Gujarat which was 14,481 in 1961 is expected to reach to 36,000 by the year 1981. Even if this difficult work is accomplished by 1981, we will have only 49.3 miles of road per 100 sq. miles as against 52 miles per 100 sq. miles for the whole country. If the State Government is able to allocate Rs. 230 crores, we will be able to bring every village within 4 miles of the metalled road and within 1½ miles of the kutcha road. A large network of roads will have to be thought of to enable mechanical transport to every village. It must be realized that this responsibility will be thrown on our newly created Panchayats.

Even in irrigation, our State is far behind the other States. The percentage of actual irrigation in the State is as low as 41. But this percentage, low as it is, is not available to the lands in command. We have not been able to utilize the available irrigation waters. It has been rightly pointed out that the enormous supply of water made available by major and minor irrigation schemes are remaining unutilized from year to year. There are many reasons for this but the most important is the inadequacy of our water distribution system. The irrigation system brings water at the head of an area as large as 500 acres and the cultivators are left to make their own arrangements to make the water reach their fields. Again, this responsibility will have to be borne by the Panchayats.

Paucity of electric power is the greatest handicap in our State. It was estimated that the total load demand in Gujarat would be about 520 MW by the end of the Third Plan. In fact, we will be able to generate only 287 MW by the end of 1966. The Dhuvaran thermal power station is supposed to add 200 MW. Even if this is fulfilled, there would be a deficit of about 33 MW at the end of the Third Plan. It is too much to expect that all the 18,584 villages of Gujarat with their agricultural lands will be supplied with electric power in the near future. This factor has a great bearing on the question of increasing our agricultural production, on the assumption that water for irrigation schemes will be made available. I am emphasizing this point simply because increasing urban industrialization will be always needing more and more power and rural areas will, as a result, receive less attention. According to the present system, the rural areas, being remote, have to pay higher tariff. In regard to industries situated in big cities like Ahmedabad, Bombay, etc., the charge per unit of power is less than those located in rural areas. Agricultural production is as important as industrial production. A time may come when the Panchayats will have to think of generating electric power on a small scale for being used locally. It must be remembered that while the percentage of increase in urban population between 1951-61 was about 21%, the rural population, during the same decade, increased by 23%.

Beside roads, irrigation water and power, there are other factors such as chemical fertilizers, mechanization of agriculture, etc. which are equally important for increasing agricultural production. The problems of the Panchayats are both administrative and technical. Unless P.W.D. personnel are fully integrated within the framework of the Panchayats, their functioning cannot be smooth. Here is some difficulty, but it must be solved. The creation of the Panchayat Raj in the various States has heralded a new means of rural regeneration. It demands service with impatience. The success of the Panchayat Raj, amongst various factors, depends upon the efficient functioning of the P.W.D.

Looking to the tremendous work expected from the Panchayats, the scanty financial resources made available to them (including Block Development work), is discouraging.

In our country, by and large, about 15% of the population lives in metropolitan areas like Bombay, Calcutta, Delhi, Madras and such other cities where the population has exceeded half a million. As against this, 85% of the people live in more than half a million villages and thousands of towns. Thus, those in the cities have to draw support directly or indirectly from the industries for their living. On the other hand, 85% of the population depends upon rural or rump economy Growing industrialization in the metropolitan areas has a tendency to kill all non-agricultural production in a rural economy. This has resulted in unemployment for the growing rural population, and a process of flight from the rural areas to metropolitan areas has started. The rural population coming into metropolitan areas creates quite unmanageable problems, which no amount of industrialization or planning is capable of solving. Hence, the growing distribution of non-agricultural production in rural areas through irresistible competition from the metropolitan areas must be stopped and replaced by a systematic development of non-agricultural production in rural areas. To quote Mr. E. F. Schumacher,

'The depending poverty of the rump economy containing 85% of the population, is primarily due, I suggest, to the progressive destruction of non-agricultural production, the decadence of agriculture itself being the inevitable result of cultural starvation due to this destruction. Agriculture alone cannot sustain a fully human life; it thrives only when in contact with industrial crafts of all kinds and when vivified through cultural influences coming from thriving towns nearby.

Modern industry tends to congregate in the metropolitan areas, nothing succeeds like success; the more industry there is already, the easier it is to start new enterprises. This tendency is noticeable all over the world. In England, there is a tendency for London to attract all industries not strictly tied to a special location and to grow into a vast conurbation with a diameter exceeding hundred miles. The United States is tending to develop three enormous centres, for which they have coined the word 'Megalopolis'—one along the eastern seaboard from Washington to Boston, one around Chicago, and the third centred on Los Angeles. In Mexico, the planners seem to have woken up to the fact that most of the 'development' automatically takes place in and around Mexico city, while most of the non-agricultural production in the rest of the country is dying off. Such developments are grave burdens to rich countries; but they spell utter misery for millions of people in poor countries.

It must be clearly understood that agriculture alone can produce a decent standard of living for a sizeable community only in very special circumstances: (a) agricultural output per person must be very high, which is rarely attainable unless the ratio of land to people is exceptionally high; (b) in addition, there must be a large market for agricultural products in the cities so that the farmer can cover all his non-agricultural consumer needs by exchanging his food surpluses for town-produced goods and services. But this presupposes that the rural population is small in relation to the town population, as it is in Britain, the United States or Germany, or else, that there is a large food export trade. As these conditions are rarely given, the general rule is that rural communities can be prosperous only when they engage in a great deal of non-agricultural production, so that most of their consumers' needs can be covered without having to exchange food surplus with the towns'.

It must be thus clear that unless there is development of non-agricultural production outside the metropolitan areas, there is no hope of a tolerable standard of living for about 85% of rural population, because the ratio of land to people in our country is highly unfavourable and high agricultural productivity per head is not possible. There is, yet another reason and it is the proportion of rural to town population—even if every farmer could produce a large food surplus, the market in the towns and cities would not be large enough to accommodate all the farmers. Further, the appearance of increase in the National Income due to industrialization in metropolitan areas is yet another sign of the degradation and impoverishment of rural population, since it means extinction of non-agricultural production in rural areas.

In the Third Plan, there is some lip-service to 'balanced regional growth', and it is proposed to set up a number of industrial estates to be located in some small and medium sized towns. In spite of this, in Gujarat, we have industrial townships one each near Ahmedabad, Baroda, Surat, Bhavnagar and Porbandar, which are not small or medium sized towns. Thus, the plan has left the location of industries more or less to the pull of natural forces. What our country needs, however, is an industrial policy in terms of location, leaving the choice of the industry more less to local initiatives and requirements. In the absence of such a policy, about 70% of the private sector industries will get concentrated in the six cities of our country.

The agriculture problem or for that matter any problem of rural India cannot be considered as an ad hoc problem. It should be taken up as an integral part of the total development of rural India. Unless this is done, any isolated effort at the improvement of a particular phase of rural India will hardly touch the fringe of the problem. In the above background, the task before us, engineers, is to serve rural India with the resources available. It is time, we engineers in this country, become soil conscious. In his Presidential Address, Shri M. M. Patel said that even for the traditional macadam roads, a higher percentage of CBR value in soil sub-grade reduces the thickness of the road by almost one-half. This shows that engineers will have to take recourse to the methods of soil stabilization not only for roads, but for other constructional works as well.

Major irrigation schemes can take their own course. Greater attention will have to be paid to minor irrigation schemes. We lag behind in the matter of roads, irrigation and power compared with the other States. We are also lagging behind in the matter of ordnance maps. It is therefore very necessary that every watershed of Gujarat (even a minor one), should be shown on these maps. Watershed treatment has been found to be of unaccountable help in achieving (i) stoppage of soil erosion ; (ii) greater infiltration of underground water (coupled with a systematic programme of afforestation) ; (iii) prevention of floods ; and (iv) utilization of local rainfall locally.

The first work to be done, therefore, is to have a series of local plans demarcating all our watersheds. By watershed I mean, the total land area of any size above a given point on a waterway that contributes runoff to the flow at that point. If we can guard our watersheds with a systematic programme of afforestation, we will be assured of ample underground water, enabling us to tank and well irrigation in a greater measure.

It will be a long time before the Gujarat Electricity Board will reach all the 18,000 villages with power. There is the serious question of domestic fuel, which has been doing immense damage to rural India. This is really a national problem that merits far more attention than it has received. A survey made by the National Council of Applied Economic Research some years ago estimated the annual consumption of domestic fuel at about 97 million tons of coal equivalent, of which 95% was met by cowdung, firewood and farm wastes, and only the balance from commercial sources such as kerosene, gas, coal and electricity. More recently, the Energy Survey Committee has estimated that over 183 million tons of coal equivalent was used for domestic purposes in 1960-61 and that at the present rates of consumption, this may go up to 210 and 270 million tons by 1971 and 1981 respectively. A steady increase in the consumption of kerosene would not be in the national interest. On the other hand, the country is already burning the equivalent of 12 Sindris per annum in terms of cowdung, while dependence on charcoal and firewood is leading to the serious problems of deforestation, erosion, siltation and floods. We can solve this power and fuel problem by obtaining methane from the cowdung. After extracting methane, the residue, it is found, retains the original manure qualities. Every cattle yields about 20 lb. of cowdung per day and each lb. can give us about 0.75 c.ft. of methane.

In the work of regeneration of rural India, there is great challenge to the engineers and the politicians alike. Unfortunately, the country has sought the solution mainly through a centralized mode of industrialization, showing only lip-sympathy to a decentralized mode of production.

In conclusion, I like to report on the activities of the Gujarat Centre. We are only four years old. We have been able to house ourselves in the premises of the Gujarat Institute of Civil Engineers and Architects, for which we are grateful. We need land to build our own premises. I appeal to the Government of Gujarat to make available a piece of land, preferably opposite this Institute, in the same way as the other States have done.

We have also started academic and research work in collaboration with Gujarat Institute of Civil Engineers and Architects on the subject of structural engineering. We have been building a technical library but we need funds to expand it and to equip a technical laboratory.

For fulfilling these, I appeal once again to our Government for benign help.'

Summaries of papers published in the Journal, Vol. 46, No. 2, pts. EL 1, CH 1 & PH 1, October 1965

ELECTRICAL ENGINEERING DIVISION

Generalized Approach to Electrical Machines and Development of their Equivalent Circuits

P. Kundu

Non-member

In this paper, the basic principles of electrical machines are deduced following Newton's Laws of Motion. Duality principle of magnetic and electric circuits is used to derive a rigorous equivalent electric circuit for a single-phase transformer. From this fundamental circuit, equivalent electric circuits for induction, commutator, synchronous, D.C. and synchronous converting machines are gradually developed. Saliency in the pole system is represented by a modified magnetizing impedance which comprises an element having a reactance and a negative resistance in series, connected in parallel with another element having a reactance equal to the direct-axis armature reaction reactance. Saturation and harmonic effects are also considered for rigorous treatment. Step by step development of the equivalent circuits shows that there is a basic unity underlying all types of electrical machines. They are not really so diverse as they appear to be and hence their study can be generalized and experimental results on synchronous type machines prove the correctness of the approach. In comparison with matrix and tensor analysis which also try to give a generalized electrical machine theory, the equivalent circuit method provides a rather simple approach which can be easily understood.

Self-Regulation of Alternators—a New Device

S. C. Rao

Non-member

This paper describes a static voltage regulator, comprising a transformer and four silicon rectifiers connected as a bridge network, for use with low power single-phase alternators and compares its performance with that of the commutator-brush system of voltage regulation. The paper also indicates that due to its economic and robust construction, such units are particularly suitable for use in military and marine installations.

Fair Weather Corona Loss on Bundled Conductor Lines

V. N. Rikh

Associate Member

No suitable formula of proved merit is so far available for determining the corona loss characteristic of transmission lines using bundle-conductors. A formula for the estimation of corona loss in bundle-conductor lines has been developed from the fairly established corona loss characteristics of single-conductor lines and the known re-distribution of surface voltage gradients when these conductors are used as subconductors in a bundle. The results obtained from this formula are expected to be of help in the design of extra high voltage lines, which generally have bundle-conductors.

Single-Phasing of Three-Phase Induction Motors

Prof. T. V. Sreenivasan

Associate Member

Three-phase squirrel cage induction motors have found wide applications in land-based industries as well as in marine installations, due to their trouble-free operation and least maintenance requirements. These motors run even when one of the three-phase lines gets open circuited, provided the supply in the other two phases are maintained.

This phenomenon is known as 'single-phasing'. This paper presents a theoretical analysis of the various performance criteria of three-phase squirrel cage induction motors under 'single-phasing' condition ; and describes the details of the tests carried out for the experimental verification of the same.

Application of Linear Graph Theory for the Solution of Statically Indeterminate Structures

N. K. Suryanarayanan

Non-member

Kirchhoff originally formulated the graph theory for the study of electrical networks. Steadily, however, over the years, the applications of the graph theory have been increasing : the theory of switching, the theory of sequential machines, the calculus of binary relations, enumeration problems in fields such as chemistry and phychology are all typical examples of the utilitarian aspects of the graph theory. The applications of the linear graph theory in establishing mathematical models of a few physical systems, *e.g.*, electrical, electromechanical, mechanical and hydraulic systems, have been discussed by several authors. This paper presents the analysis of yet another physical system, the structures, exploiting the properties of the linear graph.

CHEMICAL ENGINEERING DIVISION

Chlorella—a Future Food

Prof. S. K. Gajendragadkar

Associate Member

The population explosion in the world has set the pace of research for sources of food other than agriculture. The possibilities of algae as a source of human food is suggested now, and the economic feasibility of large scale economic exploitation of this special property of algae is under study the world over. This paper presents the study of one important genus of algae, Chlorella, which can be taken as a representative of green algae, and analyzes its possibilities as a source of human food.

Electrode Boiler

B. A. R. Somayajulu

Non-member

and

M. Allabaksh

Associate Member

The electrode boiler is a modern equipment for steam generation and has wide applications in the chemical industry. This paper describes the principle and mode of working of a typical electrode boiler working at the Oil Technological Research Institute, Anantapur, for the past several years. Its advantages and limitations as compared with the ordinary boiler are discussed.

Manufacture of 1,000 kg Liquid Chlorine Container for Transportation

K. C. Srivastava
Associate Member

The transport of chlorine and other liquefied gases for process purposes has posed a great problem to the chemical industries in India, owing to the non-availability of large size containers. At present, such containers are imported from the U.K. and the U.S.A. This paper describes the attempts made by the Indian Sugar and General Engineering Corporation for the manufacture of liquid chlorine containers of 1,000 kg capacity from indigeneous resources. It presents the theoretical considerations of design and the practical procedures for the manufacture of such containers.

PUBLIC HEALTH ENGINEERING DIVISION

Studies on River Pollution—2 : Pollution of Daha River in Bihar by Industrial Wastes

T. R. Bhaskaran
Non-member
N. Das
Non-member
S. N. Sinha
Non-member
and
J. Prasad
Non-member

Pollution of river water by the inflow of industrial wastes is on the increase in India as a result of rapid industrialization. This may assume harmful proportions and greatly affect public health, unless proper study of each problem is carried out and remedial measures are taken. This paper describes a survey undertaken to determine the extent of pollution of the Daha River in Bihar State by the discharge of wastes from the adjoining sugar factories and distilleries. It also presents experimental results and suggests remedial measures for the mitigation of pollution with particular reference to the use of river water in the region served by the Daha.

Use of Sewage for Producing More Food

O. P. Bishnoi
Associate Member

The low productivity of the arable lands in India is causing great concern. The addition of nitrogenous fertilizers greatly helps in the replenishment of the fertility of the soil. Till such time as nitrogenous fertilizers can be supplied in plenty and economically to the farmers of the country, the utilization of all forms of manure should be encouraged and all possible wastes of sufficient manurial value should be utilized. In many countries, the use of treated sewage effluent of towns and cities for land

irrigation has been in practice. Where conditions do not permit utilization of sewage on land, it has been profitably used for pisciculture. Sludge from sewage can be used for preparing compost. This paper describes the possible uses of sewage effluents for agriculture and pisciculture after adequate treatment so as not to be harmful from the point of view of public health and environmental sanitation.

Evaluation of Laboratory Sand Filtration

A. K. Deb

Associate Member

and

Dr. L. B. Polkowski

Non-member

A set comprising three laboratory type rapid sand filtration units was used to measure the head loss in the different layers of a sand bed, when coagulated influent water having uniform suspension was let into it at different rates of flow using fine, medium and coarse media. An empirical relationship between the rate of change of head loss and the depth at the time was developed for the different layers of the sand bed. At the end of a run, the surface layers in the filters were agitated and the filter was put into operation again without washing ; and more filtered water was obtained without deteriorating the quality of the effluent. This proves that surface agitation may be adopted in a water filtration plant to increase the duration of filter run.

Functional Design of Septic Tanks

R. C. Singh

Associate Member

Septic tanks are used for the disposal of sewage effluents in large areas when organized sewerage systems do not exist. This paper presents a brief survey of the development of septic tanks and analyzes theoretically the method of their design. From a comparison of the various recommendations for septic tank design, an improved method of septic tank design is also suggested.

INSTITUTION NOTICES

RULES FOR SUBMISSION OF PAPERS FOR THE *JOURNAL*

(as approved by the Council at its 442nd Council Meeting at Bangalore on 28th August, 1965)

So far, for papers submitted for publication in the *Journal* of the Institution, a set of 'Requirements' was supplied to intending authors and was generally being followed. With the greatly increased volume of publication work, it was found necessary to expand these 'Requirements' into 'Rules for Submission of Papers for the *Journal*' and accede these Rules to the Manual of Rules and Procedures of the Institution.

These rules as approved by the Council at its 442nd Meeting at Bangalore on 28th August, 1965, are given below for information of members and intending authors.

1. Papers should be submitted to the Headquarters, and all communications concerning papers and publications and associated enquiries should be addressed to the Headquarters.

2. Three manuscript copies, accompanied by one set of original Indian ink drawings and two sets of blueprints (one attached to the second copy and another to the third copy of the manuscript) and at least two sets of glossy photographs, if any, should be submitted, with the author/s retaining copies for his/their own file. The author/s should give his/their name/s in full, grade of membership and membership number, designation, and present address. Any change of address at a subsequent date should also be promptly informed.

3. Length of a paper should not generally exceed 5,000 words and should include the most salient features of the work described in an orderly presentation conforming with conventional usage in the *Journal.*

4. The main title of the paper should be brief and self-explanatory, so as to convey precisely the object of the paper. Footnotes should be generally avoided.

5. The text including quotations from other works, etc. should be typed double-spaced on one-side only, in good quality paper of quarto size (8.5 in. × 11 in.) with a generous margin at the left-hand side. The desirable format for the manuscript is shown in the 'style sheet'. The instructions given in the style sheet should be followed when typing the copies.

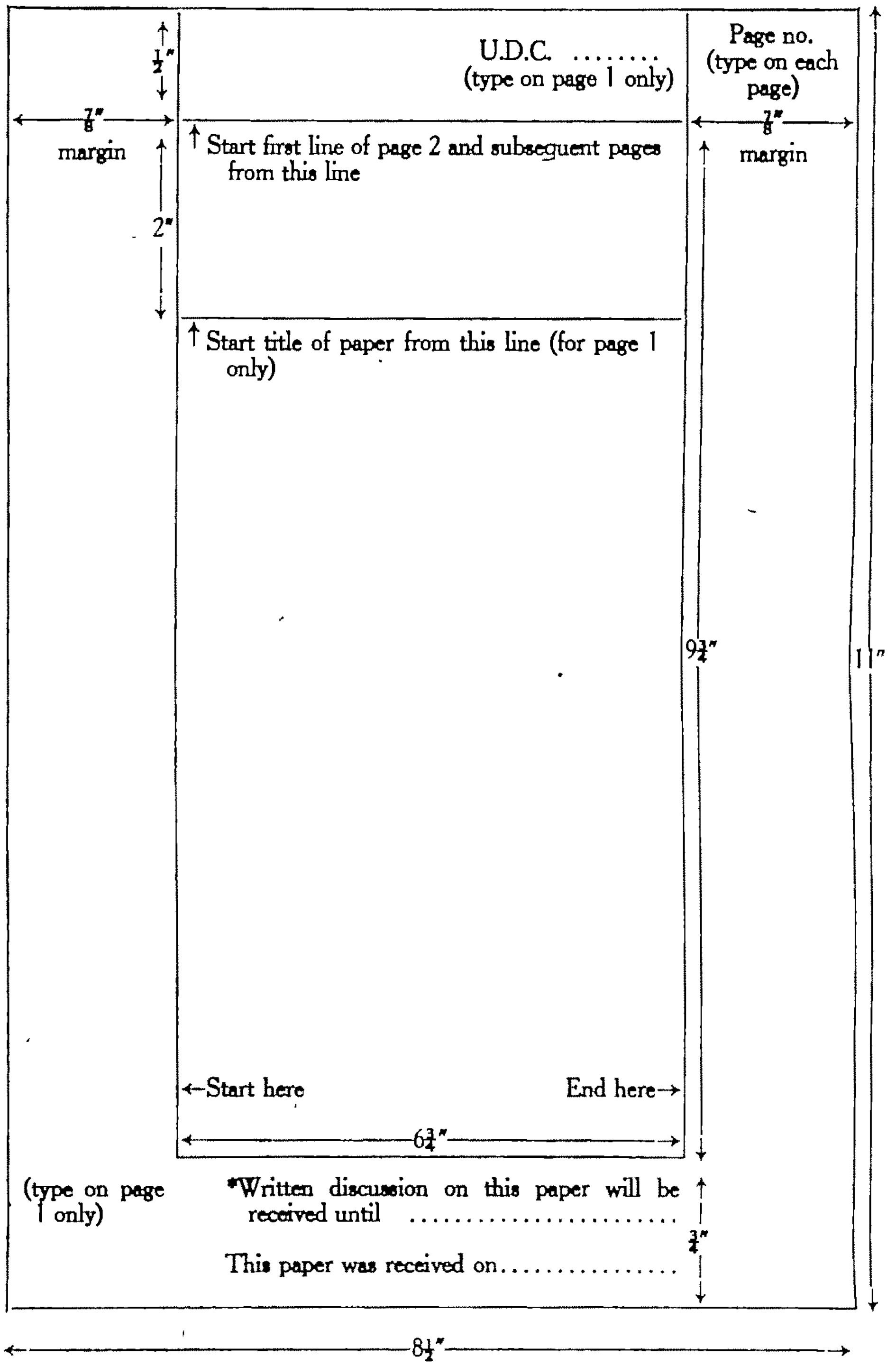
6. No attention will be paid to loose leaflets, disorderly and handwritten manuscripts, cyclostyled texts, manuscripts on inferior quality or thin paper, and anonymous contributions, not accompanied by a forwarding letter.

7. In their own interest, authors should seek prior permission of their employers or patent protection, etc., if necessary, before the paper is submitted. The Institution can accept no responsibility in this matter. Papers should be devoid of derogatory remarks or matters of advertisement value or personal interests.

8. The paper should not be submitted to another journal till a decision is given by the Institution and, when accepted, till it is published in the *Journal.* The author/s will be asked to declare to this effect upon submission of the paper. Permission should be obtained from the Institution if the paper is to be reprinted in any other publication.

9. The paper should commence with a summary of not more than 250 words, and end with an itemized account of findings and conclusions. The presentation should be in the third person. The summary should be clearly typed double-spaced on a separate sheet (of quarto size) and attached to each of the manuscript copies.

Style sheet for format of manuscript



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10. The printed page of the *Journal* is 4⅝ in.×7⅝ in. Illustrations should not be more than about twice this page size, to facilitate reproduction which is limited to a maximum of one printed page size. All illustrations should contain short, descriptive captions and be numbered consecutively in Arabic numerals without distinction between tracings and photographs, and each of them should be appropriately referred to in the text. Lettering on illustrations should be done using stencils of a size commensurate with the size of the drawing and large enough to give a clear reproduction when reduced to page size. Illustrations should be sparingly used, and should not be pasted on the pages of the manuscript. Folders, blueprints, large tables and colour features are positively discouraged. Nomograms also, if contained in the paper, should be clear and with well-defined texual entries for being accommodated strictly within the page size.

11. Mathematical and chemical notations and abbreviations and Greek letters must be legibly hand-written (in no circumstance should they be typewritten); and special notations, if any, should be written out by hand additionally, with care to distinguish letters and figures with similar characteristics, specially when typed [*e.g.*, 1 (*the number* '1') and 1 (*the letter* '1')], capital and lower case letters, and superior and inferior symbols. Notations and symbols should be entered in a single list with appropriate explanations following the summary at the beginning of the paper, and explanations should not be repeated in the text. Where types are not available, alternative notations may have to be made use of in editing the text for the press. The final proof to be passed for printing will be matched up with the original manuscript as far as it is discernible. If an author does not give attention to these requirements at the manuscript preparation stage and later claims that corrigenda must be issued to clarify mistakes (that may have occurred in the printed text as a result of illegible and indistinct script in the original paper), the corrections will be announced in the next available issue of the Journal as 'author's corrections', and the author will be charged an appropriate fee.

12. Presentation of extensive test data in the paper is discouraged as it will be of limited interest to a few analytical readers; where absolutely necessary, they may be given in the form of a table which when printed will not exceed 4⅝ in.×7⅝ in. The number of such tables should be restricted to the minimum. The tables should be consecutively numbered in Arabic numerals and each of them should contain a brief heading. Specific references should also be given in the text or in the Appendix where these tables occur.

13. References should be cited in the text by superior numbers and arranged in sequence at the end so that each number corresponds to only one reference. It is important that each reference should include, in the case of a paper or an article, the initial/s and name of the author/s, full

title of the paper or article, and the periodical (the title must not be abbreviated) where it was published with its volume, number, month and year, and page number. References to papers and articles without authorship are not permitted. If they become unavoidable in presenting the paper, they may be included in the text. Book references should include the initial/s and name of the author/s, title, edition, publisher, and year of publication. References to standard handbooks, etc. should give the title of the book, the publisher and the year of publication, and number of the edition. In the case of research reports, theses submitted for higher degrees, etc., similar and appropriate details should be included. Unpublished material and personal communications should not be included. Full credit should be given to any quotation and references that have been drawn upon. References lacking in these details will be completely omitted.

14. A copy of the proof of the paper may be sent to the author if considered necessary. It is not possible to do so in every instance owing to the volume and rigorous time-schedule of the publications. Where the proof of a paper is sent, excepting textual corrections of a minor nature, no others such as stylistic changes, corrections to illustrations and tables, corrections involving resetting, changes in layout, typeface, etc. will be accepted. If the request by the office as to the last date of return of the corrected proof is not complied with by the author, printing cannot be held back owing to the strict press-schedule imposed in bringing out the *Journal* every month. Accepted papers may be referred back to the author in case the requisite types are not available to compose the textual and mathematical notations and other details. In such a case, the author may be required to indicate alternative notations or redraft the paper with alternative symbols.

15. In the section 'Acknowledgments', the author should indicate clearly the initials and names of person/s who have assisted him in the preparation of the paper and his/their designation/s as well as other sources of information from which matter has been drawn upon.

16. The decision of the Institution to accept or reject a paper is final. A paper may be returned to the author for redrafting or revision if considered necessary. The author will be informed by a letter when his paper is approved. At that stage, however, the specific month of its publication cannot be given.

17. If the paper is written by a single author, he will receive 25 complimentary copies of reprint of the paper after publication ; if written by two authors, each author will receive 15 copies ; and if written by more than two authors, each author will receive 10 copies. Extra copies of reprint will be supplied on payment, if request is made within 15 days of the author being informed of the acceptance of his paper for publication. Original tracings and photographs will be returned to the author, as far as

possible, in the same condition as they are received from the press. The Institution accepts no responsibility for damage to such tracings and photographs caused by circumstances beyond its control.

18. Articles published in the *Journal* or *Bulletin* can be reprinted elsewhere provided prior permission is obtained from the Institution. Such reprinting must carry the correct title of the article and name, etc. of the author as they appear in the original and the *Journal/Bulletin* where it is published and its volume, number, part and month and year. Requests for blocks of illustrations for making such reprints cannot be complied with.

19. Complimentary reprints of discussions on papers published in the *Journal* will not be supplied.

20. A paper approved by a Division/Group Chairman for publication in a particular Division or Group cannot be transferred to any other Division or Group.

21. Only papers written by Corporate Members and printed in the *Journal* will be eligible for awards and prizes.

22. Papers by non-members are also considered for publication, if approved.

23. These rules are specifically made by the Council to facilitate proper manuscript preparation and quick disposal of papers approved for publication. Papers which do not conform with these may be rejected on receipt.

The Sir R. N. Mookerjee Prize

The Sir R. N. Mookerjee Prize was instituted in 1936 and is available for the best paper read by a Student at each Local Centre of the Institution. The value of the prize is Rs. 50.00. Students may submit papers to their Local Centre for approval of the Committee, or read them at a meeting of their Centre and subsequently get them approved. The paper adjudged to be the best will be given the prize, which will be in the form of books, instruments, etc., of a value not exceeding Rs. 50.00.

Draft Indian Standards

The following Draft Indian Standard has been issued recently.

1. Draft Indian Standard Specification for Hexagonal Bolts and Nuts (M42 to M150) —Doc : EDC 27 (1035).

This Standard covers the requirements of hexagonal bolts and hexagonal nuts of thread diameters 42 to 150 m.

Members may send their comments on this draft Standard before November 30, 1965, to Dr. S. P. Luthra (*M.*), Senior Professor and Head of Applied Mechanics, Indian Institute of Technology, Hauz Khas, New Delhi 16.

2. Draft Indian Standard Specification for P.V.C. (Vinyl) Asbestos Floor Tiles—Doc : BDC 5(913)

3. Draft Indian Standard Specification for Flexible P.V.C. Flooring—Doc : BDC 5(914)

4. Draft Indian Standard Specification for Polystyrene Wall Tiles—Doc : BDC 5 (989)

5. Draft Indian Standard Methods of Test for Plastic Floorings and Wall Tiles—Doc : BDC 5 (1038)

These standards specify requirements for smooth surfaced homogeneous P.V.C. (Vinyl) asbestos floor tiles.

Members may send their comments on these Draft Standards before December 1, 1965, to Shri O. S. Murthy (*M.*), General Manager Western Railway, Church Gate, Bombay 1, who is the Institution representative on the Sectional Committee dealing with these Draft Standards and a copy to Shri K. K. Nambiar (*M.*), Chairman, Civil Engineering Division, c/o Concrete Association of India, Cement House, 121 Queens Road, Bombay 1

6. Draft Indian Standard Specification for Brass Tubes for General Purposes (Second Revision of I.S. : 407-1961)—Doc : SMDC 11 (666)

7. Draft Indian Standard Specification for Brass Bars, Rods and Sections Suitable for Forgings—Doc : SMDC 11 (597)

These Standards cover the requirements of solid drawn brass tubes for the manufacture of hard type inflators and other general purposes.

Members may send their comments on these Draft Standards before December 5, 1965, to Dr. G. P. Chatterjee (*M.*), Chief Metallurgist, Durgapur Steel Project, Durgapur 3, District Burdwan, West Bengal, who is the Institution representative on the Sectional Committee dealing with these draft Standards.

8. Draft Amendment No. 1 to I.S. : 2517-1963 Specification for Bright Bars for Threaded Components—Doc : SMDC 5 (644)

9. Draft Amendment No. 2 to I.S. : 2830-1964 Specification for Carbon Steel Billets for Re-rolling into Structural Steel—Doc : SMDC 5 (699)

Members may send their comments on these amendments before December 20, 1965, to Shri J. G. Bodhe (*M.*), Consulting Engineer, 24/28 Dalal Street, Fort, Bombay 1, who is the Institution representative on the Division Council dealing with them, and a copy to Shri K. K. Nambiar (*M.*), Chairman, Civil Engineering Division, c/o Concrete Association of India, Cement House, 121 Queens Road, Bombay 1.

Copies of the draft Indian Standards may be obtained from the office of the Indian Standard Institution, 9 Bahadur Shah Zafar Marg, New Delhi; or from its branch offices at 2332 Dr. Dadabhoy Naoroji Road, Bombay 1; 11 Sooterkin Street, 3rd Floor, Calcutta 13 ; 2/12 First Line Beach Madras ; or 14/69 Civil Lines, Kanpur.

INSTITUTION NEWS

Central Metric Cell in the National Buildings Organization, New Delhi

Consequent upon the business meeting on metric changeover in building industry of the National Building Organization (N.B.O.) held in New Delhi in April 1965, a Central Metric Cell has been started in August 1965. The functions of the Cell are :

1. To scrutinize the specifications prepared by State Cells so that they are converted into metric system in rationalized metric units according to the standards and codes laid down by the Indian Standards Institution ;
2. To prepare nomenclature for schedules of rates in accordance with the standards and codes laid down by the Indian Standards Institution. These nomenclatures will be adopted by the State Governments with minor adjustments to suit local conditions ;
3. To collect, collate and disseminate information on metric changeover in building industry to various State Cells ; and
4. To undertake as a long term project the rationalization and standardization of data for various items of work on regional basis in collaboration with the Indian Standards Institution.

The Central Metric Cell will start a monthly *Metric Bulletin* shortly.

Members may send any draft specifications, schedules, etc. to this organization for scrutiny and comments so that they are converted into metric units according to the standards and codes laid down by the Indian Standards Institution.

School of Research and Training in Earthquake Engineering, Roorkee

The School of Research and Training in Earthquake Engineering at the University of Roorkee, has now completed five years of useful activity. Some of the more important work done by the School relates to the strengthening of brick buildings and water towers against earthquake forces, design of machine foundations, and failure of foundations of dams during earthquakes. The School is also studying methods by which dissipation of vibration will be possible in engineering structures. Success has already been achieved in this direction in simple cases.

The School has designed and manufactured several pieces of instruments for research work resulting in considerable saving of foreign exchange. A long term programme of collecting data on the response of structures during strong earthquakes has been undertaken by establishing Structural Response Recorder Stations at various places in India. The data obtained from these recorders are expected to improve the design methods and result in overall economy in the long run.

Work on the study of wave propagation in media of different elasticity to determine attenuation of energy in their path and residual energy responsible for shaking of structures is being carried out. Study of tectonic features of seismic regions in different parts of India is also proposed. In addition to research work, the School also tenders technical advice to various Government departments and private industries in the design of engineering structures to resist earthquake forces.

The School has also established itself as a centre of advanced training. Two Yogoslav engineers are undergoing training at present in the School on Unesco fellowships. Specialized training courses are arranged periodically to Indian engineers from State and Central organizations as well as private and public undertakings and universities.

FORTHCOMING CONFERENCES

Tenth Irrigation and Power Seminar, Durgapur, October 29-November 2, 1965

The Tenth Irrigation and Power Seminar scheduled to be held at Durgapur from October 29 to November 2, 1965 (as published in the *Bulletin* dated August 1965, p. 22) has been postponed. The future date of the Seminar will be announced when available.

Symposium on 'Metallurgy of Substitute Ferrous and Non-Ferrous Alloys', Jamshedpur, 1966

The National Metallurgical Laboratory, Jamshedpur, will hold a Seminar on 'Metallurgy of Substitute Ferrous and Non-Ferrous Alloys' at Jamshedpur in early 1966.

The Symposium will cover the following grounds :

1. Theoretical principles of substitution of ferrous and non-ferrous metals and alloys in relation to metallurgical characteristics and physical properties of end products.
2. Development of substitute ferrous and non-ferrous alloys in general in different countries in times of peace and emergency including requirements of stock-pilling.
3. Development of ferrous and non-ferrous substitute alloys under Indian conditions of raw-materials and market requirements.
4. Practical aspects of substitution of ferrous and non-ferrous metals in relation to industrial production and fabrication parameters.
5. Special purposes substitute alloys developed for specific applications such as for light armour, aluminium alloy cartridge cases, substitute stainless and high speed steels, etc.
6. Study of economics of substitution of ferrous and non-ferrous metals under Indian conditions in the background of world conditions in general.
7. Standard specifications for substitute ferrous and non-ferrous alloys.

Further details can be obtained from the Director, National Metallurgical Laboratory, Jamshedpur 7.

36th International Congress on Industrial Chemistry, Brussels, September 10-21, 1966

The 36th International Congress on Industrial Chemistry, will be held in Brussels, Belgium, from September 10 to 21, 1966, under the auspices of the Society de Chimie Industrielle, having its head office in Paris.

The scientific programme includes :

1. Organization of Research : Research ; and Documentation and information
2. General Technical Problems of Chemical industry : Analysis methods and apparatus ; Chemical engineering—regulation—cold ; Corrosion ; Waters—air—fight against pollution ; and Lubrication and lubricants.
3. Fuels : Solid fuels ; Liquid fuels ; and Gaseous fuels.
4. Nuclear Sciences : Energy reactors and fuel cycles ; and Radioisotopes and advanced reactors.
5. Metallurgy : Ferrous metals ; and Non-ferrous metals.
6. Mineral Chemicals Industries : Heavy chemical industry ; and Miscellaneous chemical industries.
7. Silicates Industry : Cements ; Glassmaking—enamelling ; and Ceramics—bricks.
8. Petrochemistry and Coal Chemistry : Petro chemistry ; and Coal chemistry.
9. Photographic, Pharmaceutical and Dyestuffs Industries : Photographic products—dyestuffs—intermediary organic products ; and Pharmaceutical products.
10. Miscellaneous Organic Industries : Plastics—elastoners—textile fibres—cellulose—glues and gelatines; Powders and explosives; Paint—varnish and printing inks ; Fatty materials—soaps and detergents ; and Perfumes and derivatives.
11. Food and Agricultural Industries : Fermentation industries ; Miscellaneous food industries; and Phytopharmaceutical—industries application of fertiliser.
12. Industrial and Social Organization : Industrial and social organization.

Members wishing to contribute papers may notify the General Secretariat of the 36th International Congress before December 1, 1965, and submit the papers before April 1, 1966.

Further information can be obtained from the General Secretariat, 36th International Congress on Industrial Chemistry, 49 Square Marie-Louise, Brussels 4, Belgium.

Seventh International Water Supply Congress and Exhibition, Barcelona, October 3-7, 1966

The Seventh International Water Supply Congress will be staged in the Palacio de Las Naciones, Barcelona, Spain, from October 3 to 7, 1966.

Following on the success of the Exhibition at the Sixth Congress in Stockholm in 1964, the Barcelona Congress will also feature an International Exhibition of equipments and services used for the purposes of public water supply. This will form an integral part of the Congress.

The floor space inside the Congress Hall which can be rented to exhibitors will amount to approximately 1,150 m.^{2} in all, and there will be 332 m.^{2} of space available in the open outside the Hall for displaying large exhibits.

Well over 1,000 members and officers of public water supply undertakings from all over the world are expected to attend the Seventh International Water Supply Congress and Exhibition in Barcelona.

The International Water Supply Association has already 36 member-countries and most of them are expected to be at the Congress in force.

The scientific programme for the Congress will comprise :

(a) A general International Report on each of the following four subjects : (i) Multipurpose water schemes, (ii) Methods for determination of safe yield and compensation water from storage reservoirs, (iii) Occurrence, significane and control of organisms in distribution systems, and (iv) Manpower problems.

(b) A paper on each of the following eleven special subjects : (i) Desalting, (ii) Practical measures for the protection of water catchments against infiltration of hydrocarbons and pollution by radioactive products, (iii) Treatment of water before infiltration and modification of water quality during its passage underground, (iv) Interpretation of pumping tests on wells, (v) Long distance pipelines, (vi) Booster installations in distribution systems, (vii) Principles of complex calculation of water supply systems using computers, (viii) Calculation of water hammer and transient phenomena by electronic computers, (ix) Protection of public water supply systems against pollution by water returns, (x) Modern theory of filtration, and (xi) Treatment and use of sludge.

(c) Two Plenary Sessions of the Congress : one on Limnology and its Application to Potable Water Supplies, and one on Problems of water supply in Developing Countries.

(d) A 'Corrosion Day' for specialists in the study of correction and protection of underground pipelines.

(e) Specialists' meetings of chemists and bacteriologists.

There will also be a full programme of social functions and excursions during the Congress week and a number of tours will be arranged for the week following the Congress.

Any firm that wishes to receive full details of the Exhibition and have the opportunity of taking space may write to the Secretary General of the International Water Supply Association at 34 Park Street, London, W.1.

BOOK ACKNOWLEDGMENTS

1. **Analysis of Continuous Beams and Rigid Frames.** P. S. Dravid. *Asia Publishing House*, Bombay, Rs. 9, 1965, 95 pages.

The book attempts to present Kani's method of rotation contribution for the structural analysis of continuous beams and multistoreyed frames with the help of the well-known slope deflection equations of individual storeys. The subject matter is graded to cover the range of usual cases in logical sequence. Worked out examples are given at the end of each chapter to help the reader understand the subject better.

2. **Composite Construction in Steel and Concrete.** H. T. Yan. *Orient Longmans Ltd.*, Calcutta, Rs. 16, 1965, 210 pages.

Included in this book is information on design and construction of simply supported, continuous, plain and haunched composite beams. Phased casting of concrete, prestressing, cambering and the effects of propping are also dealt with.

3. **Estimating and Costing in Civil Engineering.** B. N. Dutta. *Published by the author.* Rs. 14, 6th edition, 1965, 672 pages.

This sixth edition of the book has been revised and enlarged and presented in metric system to make it up-to-date and useful to students, teachers, engineers, architects and others in the profession. The simple method and a method known as 'centre line method' of estimating are mentioned and the centre line method has been perfected and many illustrations of building estimates have been solved by both these methods without any difference in the result. The chapter on specifications has been revised and detailed specifications have been written pointwise. A number of selected questions and exercises in the metric system have been added.

4. **Design of Houses.** Published by Sahu Cement Service, New Delhi, Rs. 8, 1965.

This book deals with designs of low-income group, middle income group and upper income group houses. It contains twelve designs of houses for each income group and is intended to help not only the architect, the engineer, the overseer and the supervisor, but the educated layman in planning and constructing houses to suit individual needs.

5. **Engineering Drawing.** P. N. Vijayvergiya. *New Asian Publishers*, Delhi, Rs. 12.50, 1965, 330 pages.

The book lays stress on the fundamental principles of plane and solid geometry, machine drawing and also building drawing. The text is illustrated by pictorial views, and is essential to build up the basic concepts.

6. **Long-Term Storage—An Experimental Study.** H. E. Hurst, R. P. Black and Y. M. Simaika. *Constable & Co. Ltd.*, London, 30s. 1965, 146 pages.

The author has described in this book the method of investigation employed to make the fullest possible use of the waters of the Nile which involves the question of the volume storage required. The principles established are, of course, applied only to the storage of water, but they apply to storage generally and also to some of those cognate problems where it is assumed that the events are independent and randomly distributed. This publication will be of use to water engineers and other engineers who have to deal with problems of storage.

7. **Variational Techniques in Electromagnetism.** Laurent Cairo and Theo Kahan. *Blackie & Son Ltd.*, London, 27s. 6d. 1965. 152 pages.

This book discusses the application of variational methods of electromagnetic wave propagation, particularly at conducting surfaces and in waveguides. These methods often enable quantities such as the characteristic impedance of a line, the proper frequency of a cavity and the equivalent capacitance of a waveguide obstacle, to be approximately evaluated.

8. **Practical Solution of Torsional Vibration Problems.** Vol. 3—Strength Calculations, 3rd edition. *Chapman & Hall Ltd.*, London, £6, 1965, 697 pages.

This book deals with the strength and selection of materials for transmission shafting, crankshaft design, materials and production methods; and the control of torsional vibration by adjustments of the mass/elastic characteristics of the system; and concludes with an introduction to the subject of flexible couplings. The detailed treatment of the design of engine crankshafts makes this book particularly valuable to the engine designer.

9. **A History of Mechanical Engineering.** A. F. Burstall. *Faber and Faber, London*, 18s. 456 pages.

This book makes mention of the many great inventions in machines and mechanical processes used in Egypt, China, Mesopotamia, Greece, Rome, and the Arab world. The nine chapters in the book deal with mechanical engineering developments in the successive periods of history. The periods become shorter as we approach the present day and the pace of advance accelerates. Each chapter includes sections on (i) materials available to the mechanical engineer, (ii) tools, (iii) mechanism and machines for mechanical transmission of power and motion, (iv) fluid machinery, and (v) heat engines. General comments on the state of science and civilization at each period precede these sections. An account of the foundation and growth of application of the sciences of thermodynamics, mechanics and metal cutting, and of the development of automatic control mass production and aeronautics has also been included.

PUBLICATIONS RECEIVED

A copy of the *Information Bulletin No. 35* entitled 'The application of the Yield-line Theory to Calculations of the Flexural Strength of Slabs and Flat Slab Floors', has been received from the Cement and Concrete Association, 52 Grosvenor Gardens, London S.W. 1. Priced at £3, the first section of the *Bulletin* contains a complication of the various formulae relevant to the collapse of slabs according to yield line patterns, and the second section is devoted to a series of examples showing the application of the various formulae to certain forms of construction. The third section gives a summary of the experimental work that has been carried out so far in Germany, France and the United States on the subject of yield line patterns in slabs. The results are briefly compared with those calculated to yield line theory.

A copy of a publication entitled 'The Role of Patents in the Transfer of Technology to Developing Countries' has been received from the Oxford Book Co., 17 Park Street, Calcutta 16. Published by the United Nations and priced at $1.50, the publication is in two parts : the first part describes major characteristics of patent systems, and the second part deals with the effects of patterns on the economies of under-developed countries.

A copy of a publication entitled 'The Development of Groundwater Resources with Special Reference to Deltaic areas' has been received from the Oxford Book Co., 17 Park Street, Calcutta 16. Published by the United Nations and priced at $3, the publication consists of three parts. Part 1 contains the report of the Regional Seminar on the Development by Groundwater Resources with Special reference to Deltaic Areas, held at Bangkok in April-May 1962. Part 2 contains lectures by consultants on groundwater resources, and Part 3 contains the papers submitted to the above Seminar.

CORRIGENDUM

TO VOL. 15, NO. 1, SEPTEMBER 1965

Page 123, line 32, instead of 'Shri G. D. Joglekar (*Non-member*)', please read 'Shri G. D. Joglekar (*Member*)'.

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, industrial and other organizations employing engineers. It is hoped that employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

SITUATIONS WANTED

FIRST CLASS L.E.E., Student of the Institution of Engineers (India), age 26 years, with more than six years experience in electric motors and control gears, plant power supply installations, electric, electronic and hydraulic instruments and meters, hydraulic machinery, and works connected with research and development, technical correspondence, looking for a job, challenging in research and development (Defence/civil) or industrial organization (Office ref. 206).

CIVIL ENGINEER, B.E., Grad. I.E., 26 years old with good physique, having nearly four years of experience in a government organization as Assistant Engineer (Class I), in planning and investigations (including diamond drilling for foundation exploration) for dams and power houses, soil sampling and testing, conducting field tests for soil investigations including installations of piezometers, also in inspection of construction of R.C.C. structures, at present studying for M. Tech., in Soil Mechanics and Foundation Engineering, is available for employment from May 1966. Salary expected Rs. 800 p.m. (Office ref. E.S. 207)

YOUNG ELECTRICAL ENGINEER, age 23½ years, possessing first class Diploma in Electrical Engineering with Distinction and passed Sections A and B of the Associate Membership Examination of the Institution of Engineers (India) in Electrical Engineering, also doing A.M.I.E. (India), (Mech.), Graduate of the Institution, having 3 years experience in designing, planning, estimating, erection and maintenance of electrical installations in residential, commercial and office buildings including lifts, compound lighting, lighting arresters, etc; hard working, stout and of pushing nature, promotion expected soon in the present job; seeks a suitable change with bright prospectus in a leading concern of repute. Salary acceptable Rs. 750 May consider a little less also if selected for some specialized training wih bright future promised. (Office ref. E.S. 208)

A B.Sc., recently passed the Sections A and B of the Associate Membership Examination of the Institution of Engineers (India) in Metallurgy; with over seven years experience in industry conversant with planning, production and labour handling; keen aptitude for any branch of metallurgy; seeks and suitable offer for the qualifications and experience. (Office ref. E.S. 209)

YOUNG MECHANICAL ENGINEER, passed Sections A and B of the Associate Membership Examination of the Institution of Engineers (India), age 26, having 7½ years experience in overhauling and maintenance of I.C. engines, air compressors, water pumps, machine tools, cranes, preventive maintenance of all plants and machines; and installation of machines and machine shop work. At present drawing Rs. 450.00 in a well reputed British company, seeks a suitable change any where in India. (Office ref. E.S. 210)

THE INSTITUTION, ITS LOCAL CENTRES AND SUB-CENTRES

Headquarters

8, Gokhale Road, Calcutta 20.
P.O. Box No. 669
Telephone: *47-3362 (4 lines). Telegrams: ENJOIND*

Local Centres

Andhra Pradesh	Khairatabad, Hyderabad-4 (*Telephone 33036*).
Assam	P.W.D. Secretariat (R & B), Shillong.
Bengal	8, Gokhale Road, Calcutta-20 (*Telephone 47-2744*).
Bihar	Hardinge Road, Patna 1 (*Telephone 2-2639*).
Bombay	Ilaco House, Sir Pherozeshah Mehta Road, Bombay 1 (*Telephone 26-3430*).
Delhi	Bahadur Shah Zafar Marg, (near Tilak Bridge), New Delhi (*Telephone 27-2702*).
Gujarat	Law College Road, Ahmedabad 6 (*Telephone 78915*).
Jammu & Kashmir	C/o Divisional Engineer, Construction Division 1, P.W.D Srinagar.
Kerala	Observatory Hill, Trivandrum-1 (*Telephone 2663*).
Madhya Pradesh	Royal Hotel Premises, Civil Lines, Jabalpur (*Telephone 1337*)
Madras	No. 1, Adam's Road, Chepauk, Madras 5 (*Telephone 85579*).
Mysore	No. 3 Vidhana Veedhi, Bangalore-1 (*Telephone 25471*).
Nagpur	North Ambazari Road, Nagpur-1 (*Telephone 5671*).
Orissa	Sachivalaya Marg, Unit IV, Bhubaneswar-1
Poona	1332 Shivajinagar, Jangli Maharaj Road, Near Shivajinagar Post Office, Poona-5 (*Telephone 57377*).
Punjab	Sector 19A, Chandigarh (*Telephone 418*).
Rajasthan	C-46 Sarojini Marg, C Scheme, Jaipur (*Telephone 73327*).
Uttar Pradesh	River Bank Colony, Lucknow (*Telephone 25322*).

Sub-Centres

Allahabad	C/o Allahabad Polytechnic, Allahabad.
Baroda	C/o Faculty of Technology and Engineering, M.S. University, Baroda 1, Gujarat State (*Telephone 4300*).
Bhilai	Works Office Building No. 3, Bhilai Steel Works, Bhilai, Madhya Pradesh.
Bhopal	C/o Transformer Engineering Department, Heavy Electricals (India) Ltd., Piplani P.O., Bhopal (*Telephone 1791 (City)*.
Dhanbad	C/o Prof. M. S. Pal, P.O. Indian School of Mines, District Dhanbad, Bihar.
Durgapur	C/o Deputy Chief Engineer (Civil), The Durgapur Projects Ltd., P.O Durgapur-2, District Burdwan, West Bengal (*Telephone DGP-24*).
Jammu	C/o Office of the Superintending Engineer, Electric Project and Planning Circle, Jammu, Tawi.
Jamshedpur	General Engineering Division, TELCO, Jamshedpur-4 (*Telephone 612/57*).
Kharagpur	C/o Department of Metallurgical Engineering, Indian Institute of Technology, Kharagpur, West Bengal.
Nagarjunasagar	P.O Hill Colony, Vijayapuri North, Nalgonda District, Andhra Pradesh.
Neyveli	Central Technical Office, Block 1, Neyveli 1, Madras State (*Telephone 2361*)
Ranchi	C/o Electrical Executive Engineer, Ranchi Electrical Supply Division, Old Secretariat Building, Doranda, P.O. Hinoo, District Ranchi.
Roorkee	C/o University of Roorkee.
Rourkela	C/o Department of Electrical Engineering, Regional Engineering College, Rourkela-8.

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THE BULLETIN
OF
The Institution of Engineers (India)

SECRETARY & EDITOR : B. Seshadri, B.Sc., A.I.I.Sc., D.I.C. M.Sc.(Eng.), M.I.E.
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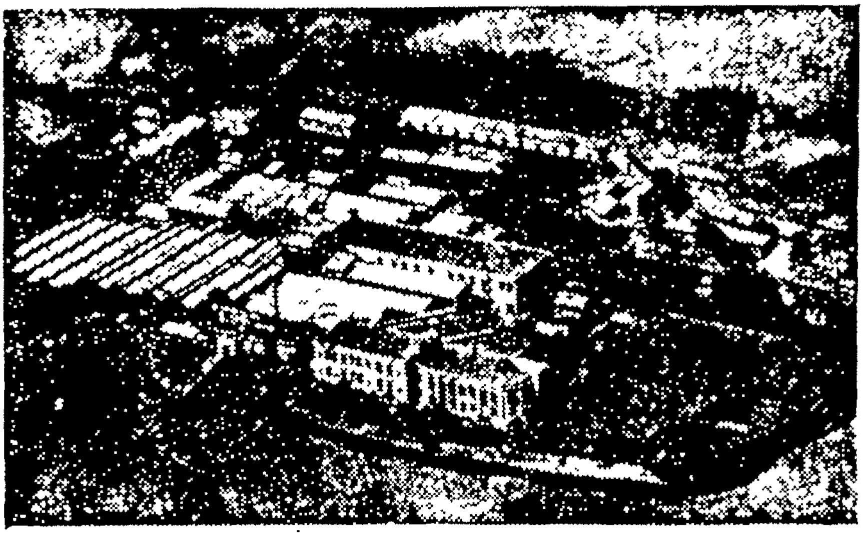

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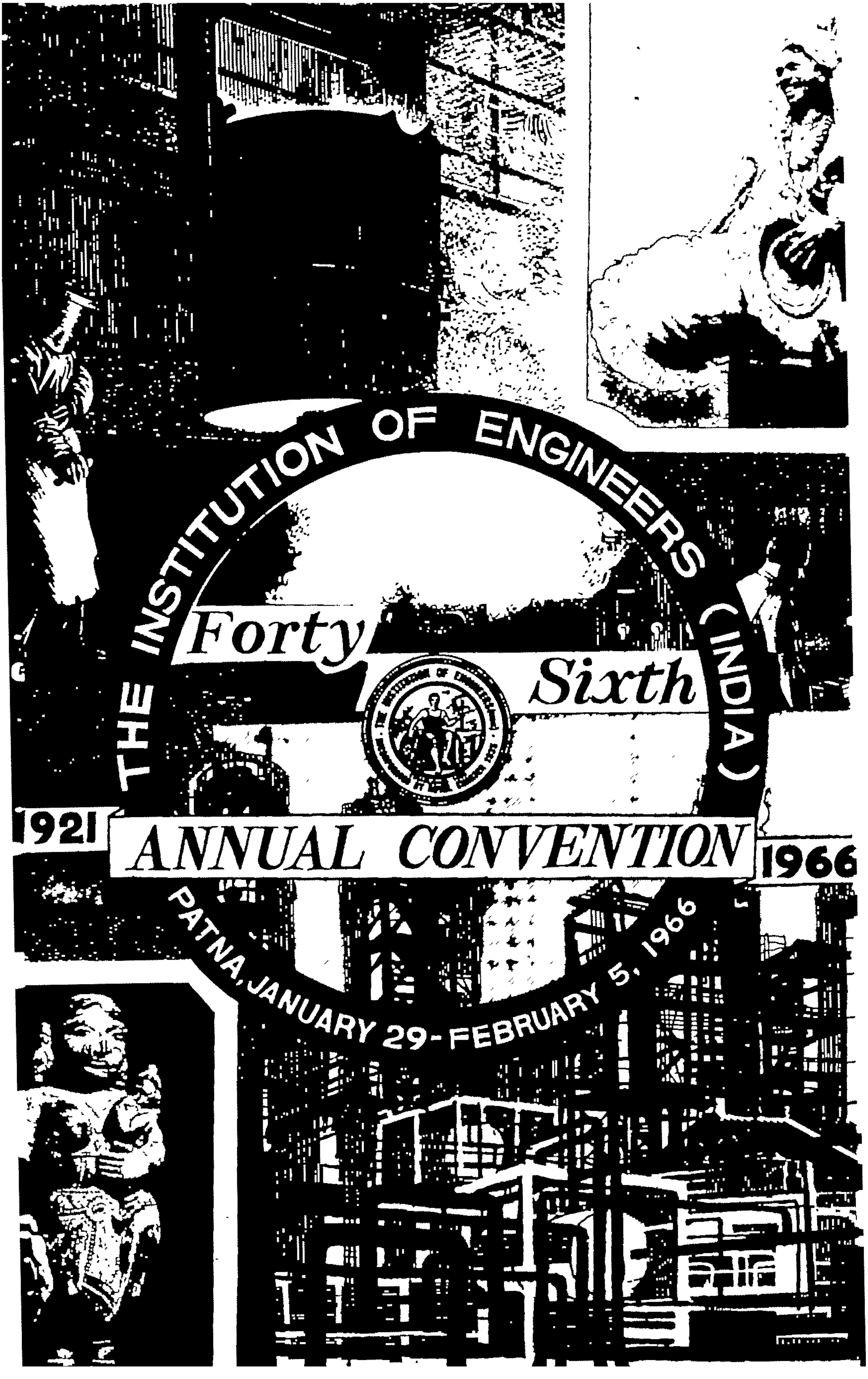


THE INSTITUTION OF ENGINEERS (INDIA)

Forty Sixth

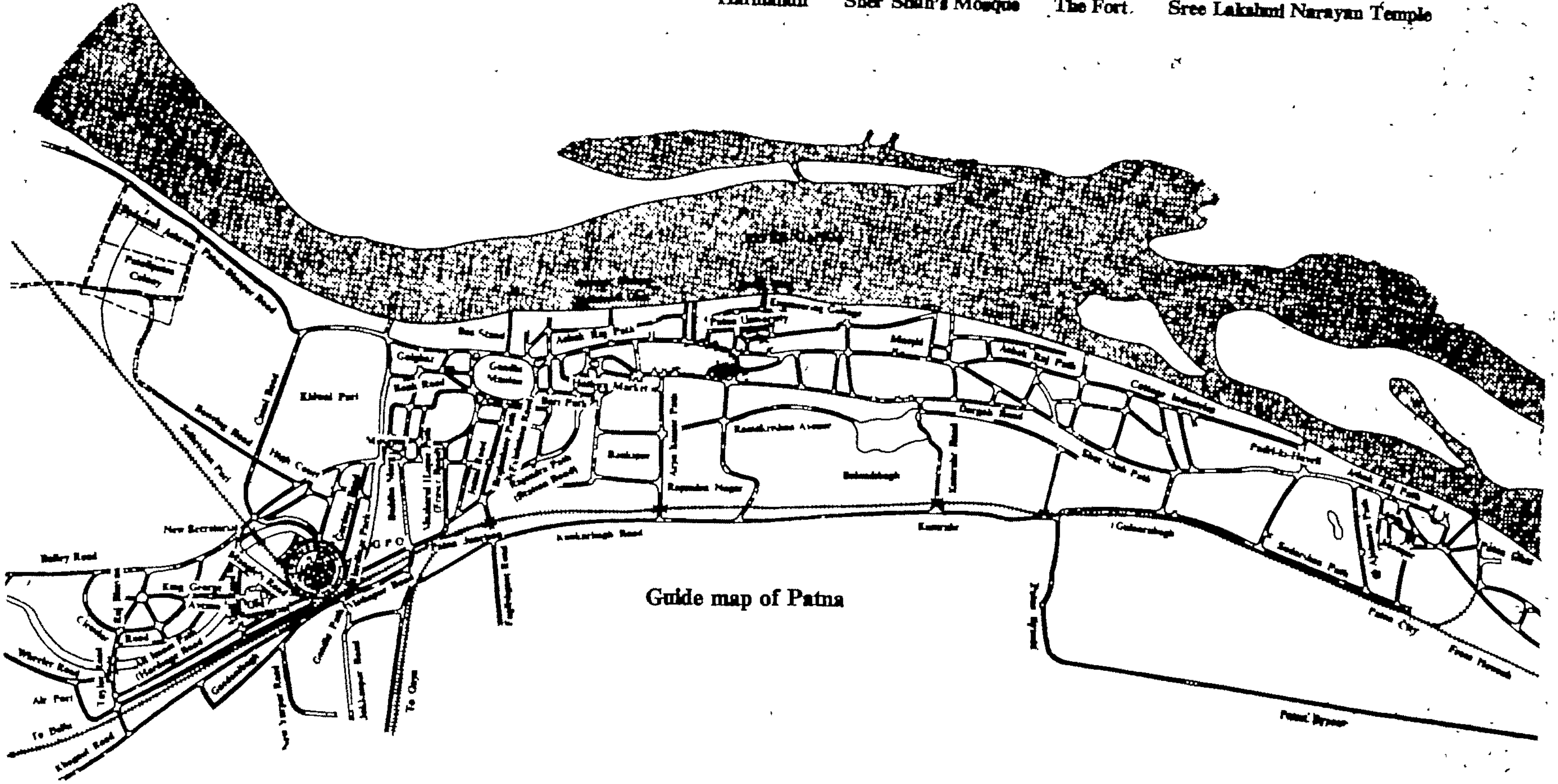
ANNUAL CONVENTION

1921 1966

PATNA, JANUARY 29 - FEBRUARY 5, 1966

Places of interest.

Martyrs' Memorial   Patna Museum   Golghar   Kumrahr   Gandhi Ghat   Pathar-Ki-Masjid
The Old English Factory   Patan Devis   Kamaldah   Chihil-Satun   Maqbera of Nawab Haibat Jung
Harmandir   Sher Shah's Mosque   The Fort.   Sree Lakshmi Narayan Temple



Guide map of Patna

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No. AGM 46

The Institution of Engineers (India)

8 Gokhale Road, Calcutta 20

December 5, 1965

The Forty-Sixth Annual General Meeting of the Institution of Engineers (India) will be held in the building of the Bihar Centre, Hardinge Road, Patna, on Saturday, 29th January, 1966, at 3.30 p.m.

AGENDA

1. To confirm the minutes of the Forty-Fifth Annual General Meeting (circulated in the April 1965 issue of the *Bulletin* of the Institution, pages 4-31).
2. To receive the Annual Report of the Council (printed in abstract in the November 1965 issue of the *Bulletin* of the Institution, pages 1-7, and the Audited Accounts for the year ended August 31, 1965 (will follow).
3. To receive the report of the Council on the election for the session 1966-67 of (i) the President ; and (ii) members of the Council.
4. To appoint Auditors for the year 1965-66 and to fix their remuneration.

B. Seshadri
Secretary

FORTY-SIXTH ANNUAL GENERAL MEETING
PATNA, JANUARY 29-FEBRUARY 5, 1966

Preparations are in full swing to celebrate the 46th Annual Convention of the Institution at historic Patna during the week January 29-February 5, 1966. For the second time, the Bihar Centre, which will have the honour to act as hosts to the Convention—the 30th Annual Convention was held in Patna in January 1950, extends to you a cordial welcome.

Special events to be held during the Convention will provide a supporting programme worthy of the occasion. A Seminar on 'The Role of the Engineer in the Fourth Five Year Plan' will supplement the usual Paper Meetings in the various Divisions and Groups. Other features include popular lectures, talks and panel discussions on technical subjects and professional problems of topical interest.

The festive Convention programme will also feature social and cultural functions and entertainment. A concurrent social programme is also being planned for ladies accompanying delegates.

An important adjunct to the technical programmes will be informative study tours to industrial plants and projects, and engineering research centres in Bihar, and visits and excursions to ancient relics of history and culture.

To ensure that their visit to Patna is rendered pleasant intending delegates are requested **to return the Acceptance Form** at the end of this programme indicating their acceptance **on or before Friday, December 31, 1965,** so that their reservations and other requirements are taken care of in good time. A separate Acceptance Form is given for the use of ladies accompanying delegates.

Delegates will please note that Patna's cold will be fairly intense even in February. They are therefore advised to bring their warm clothing. Further, it is essential that they bring their own mosquito-curtains as mosquito-trouble is rather severe here.

Members are aware that rail concession has been withdrawn by the Railway Board due to the National Emergency. However, as a result of the efforts made by the Headquarters to secure a resumption of the concession, the Railway Board has been pleased to extend, as a special case, rail concession to persons attending this Convention at Patna on production of the requisite certificate form from the Secretary of the Institution. The conditions of the rail concession are given on p. ix and the Certificate Form to be completed by the delegates is attached at the end of this programme.

THE ANNUAL GENERAL MEETING

Business Session

The Business Session of the 46th Annual General Meeting will be held at 3.30 p.m. on Saturday, January 29, 1966, in the building of the Bihar Centre, The Institution of Engineers (India), Hardinge Road, Patna.

Inaugural Session

The Inaugural Session of the 46th Annual General Meeting will commence at 9.00 a.m. on Sunday, January 30, 1966 at Bharatiya Nritya Kala Mandir, Patna.

CONVENTION PROGRAMME

Saturday, January 29, 1966

8.30 a.m. to 1.00 p.m. 2.00 p.m. to 4.00 p.m.	Registration of local* and outstation members and visitors attending the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan', at the Bihar Centre, Hardinge Road, Patna
9.30 a.m. to 11.45 a.m.	First Session of the Seminar at the Bihar Centre
11.45 a.m. to 12.00 noon	Coffee
12.00 noon to 1.00 p.m.	Second Session of the Seminar at the Bihar Centre
1.00 p.m. to 2.00 p.m.	Lunch
2.00 p.m.	Meeting of the Indian National Committee for the World Power Conference at the Bihar Centre
2.30 p.m. to 3.00 p.m.	Adjourned Meeting of the 1965-66 Council at the Bihar Centre
3.30 p.m. to 4.30 p.m.	Business Session of 46th Annual General Meeting at the Bihar Centre
4.30 p.m. to 5.00 p.m.	Tea
5.30 p.m.	A Talk on 'Bio-Engineering' by Shri J. G. Bodhe (*M.*), Member of Council, at the Bihar Centre

Sunday, January 30, 1966

9.00 a.m. to 1.00 p.m.	Registration of local and outstation members and visitors (continued) at the Bihar Centre
2.00 p.m. to 4.00 p.m.	Registration of local and outstation members and visitors (continued) at Bihar College of Engineering, Patna

---

*** Local members (from Patna) are requested to get themselves registered at the Bihar Centre, Hardinge Road, Patna, by January 24, 1966, the latest. Registration of local members may not be accepted after this date.**

9.00 a.m. to 11.45 a.m.	Inauguration of the 46th Annual General Meeting at Bharatiya Nritya Kala Mandir
11.45 a.m. to 12.00 noon	Coffee
12.00 noon to 1.00 p.m.	The Ninth Sir Mokshagundam Visvesvaraya Lecture by Dr. T. Sen, Past-President, at Bharatiya Nritya Kala Mandir
1.00 p.m. to 2.00 p.m.	Lunch
2.30 p.m. to 4.30 p.m.	Inauguration of the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan' at Bharatiya Nritya Kala Mandir
	Third Session of the Seminar at Bharatiya Nritya Kala Mandir
4.30 p.m.	Tea
	Visit to Rajgir by special train or special bus (for delegates not participating in Outstation Tours). Bath in Sulphur Springs at 7.30 p.m. Dinner at 8.30 p.m. and rest in train or Rest House

Monday, January 31, 1966

6.30 a.m.	Leave Rajgir for Nalanda (visit to last for nearly 2 hours). Leave for Patna by special train or bus
9.00 a.m. to 11.45 a.m.	Fourth and Final Session of the Seminar at Bihar College of Engineering
11.45 a.m. to 12.00 noon	Coffee
12.00 noon to 1.00 p.m.	Address by Division/Group Chairmen and Paper Meetings in the Public Health Engineering Division; Prestressed Concrete Group; Shell Structures Group; Mechanical Engineering Division; Industrial Engineering Group; Aeronautical Engineering Group; Chemical Engineering Division; Electronics and Telecommunication Engineering Division; and Automatic Control Group at Bihar College of Engineering
	Seminar (to be continued as necessary) at Bihar College of Engineering
1.00 p.m. to 2.00 p.m.	Lunch

2.30 p.m. to 4.00 p.m.	Paper Meetings (to be continued as necessary) at Bihar College of Engineering Seminar (to be continued as necessary) at Bihar College of Engineering
4.00 p.m. to 4.30 p.m.	'At Home'
4.30 p.m. to 6.30 p.m.	Students' Session—(1) General, and (2) Technical* at Bihar College of Engineering
7.00 p.m. to 9.00 p.m.	Variety Entertainment in aid of National Defence Fund at Bharatiya Nritya Kala Mandir

Tuesday, February 1, 1966

9.00 a.m. to 10.30 p.m.	Meetings of Panels for Study of Engineering Subjects of Common Interest at Bihar College of Engineering
10.30 a.m. to 11.00 a.m.	Meetings of the Division Boards at Bihar College of Engineering
11.00 a.m. to 1.00 p.m.	Address by Division/Group Chairmen and Paper Meetings in the Civil Engineering Division; Roads and Road Transportation Group; Railway Engineering Group; Mining and Metallurgy Division; Petroleum Engineering Group; Electrical Engineering Division; Nuclear Engineering Group; and Marine Engineering and Shipbuilding Group at Bihar College of Engineering
1.00 p.m. to 2.00 p.m.	Lunch
2.00 p.m. to 4.30 p.m.	Paper Meetings (to be continued as necessary) at Bihar College of Engineering
4.30 p.m. to 5.30 p.m.	'At Home'
6.00 p.m. to 8.00 p.m.	Variety Entertainment in aid of National Defence Fund at Bharatiya Nritya Kala Mandir

Wednesday, February 2, 1966

9.00 a.m. to 10.00 a.m.	Meeting of the Engineering Education and Research Committee at Bihar College of Engineering

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* Students desirous of presenting papers at this Session should send their manuscripts to the Headquarters Office at Calcutta not later than Friday, December 31, 1965.

9.00 a.m. to 12.00 noon	Paper Meetings (to be continued as necessary) at Bihar College of Engineering
	Seminar (to be continued as necessary) at Bihar College of Engineering
12.00 noon to 1.00 p.m.	Closing Session of the 46th Annual General Meeting at Bihar College of Engineering
1.00 p.m. to 2.00 p.m.	Lunch
3.00 p.m. to 3.30 p.m.	Meeting of the 1966-67 Council at Bihar College of Engineering
3.30 p.m. to 5.00 p.m.	Local Visits for delegates participating in Outstation Tours
7.00 p.m. to 10.00 p.m.	Commencement of Outstation Tours
Thursday, February 3, 1966	
9.00 a.m. to 1.00 p.m.	Local Visits for delegates not participating in Outstation Tours
Friday, February 4, 1966	Outstation Tours in progress
Saturday, February 5, 1966	Conclusion of Outstation Tours and dispersal

PROGRAMME OF INAUGURAL SESSION OF THE CONVENTION TO BE HELD AT PATNA, ON SUNDAY, JANUARY 30, 1966

The itemized details of the Inaugural Session of the Convention to be held on Sunday, January 30, 1966, are given below.

(1)	9.00 a.m.	The Chief Guest arrives. Introduction of the Chief Guest to the Council by the retiring President, Prof. N. S. Govinda Rao, and the President-Elect, Shri B. P. Kapadia.
(2)	9.15 a.m.	Group photograph of the Council with the Chief Guest.
(3)	9.25 a.m.	Welcome to the Convention by the Chairman of the Reception Committee.
(4)	9.35 a.m.	Announcement of Prizes by the retiring President, Prof. N. S. Govinda Rao and their award by the Chief Guest.
(5)	9.45 a.m.	Conferment of Honorary Life Memberships.
(6)	9.55 a.m.	Introduction of the President-Elect, Shri B. P. Kapadia, by the retiring President, Prof. N. S. Govinda Rao.
(7)	10.05 a.m.	Presidential Address by Shri B. P. Kapadia.
(8)	10.50 a.m.	Inaugural Address by the Chief Guest.

(9) 11.35 a.m. Vote of thanks by the Chairman of the Bihar Centre.
(10) 11.45 a.m. Coffee.
(11) 12.00 noon The Ninth Sir Mokshagundam Visvesvaraya Lecture by Dr. T. Sen.
(12) 1.00 p.m. Vote of thanks to Dr. Sen.

THE NINTH SIR MOKSHAGUNDAM VISVESVARAYA LECTURE

'To honour the outstanding achievements of Sir Mokshagundam Visvesvaraya in the field of engineering, the Lecture will deal with a cultural subject allied to engineering and will be of interest to all engineers'. This Lecture was initiated and established by the Institution in 1957.

The Ninth Sir Mokshagundam Visvesvaraya Lecture will be delivered by Dr. T. Sen, Past-President, following the Inauguration of the Convention, at 12.00 noon.

SEMINAR ON 'THE ROLE OF THE ENGINEER IN THE FOURTH FIVE YEAR PLAN'

This Seminar will be held in four sessions and will be inaugurated at 2.30 p.m. on Sunday, January 30, 1966, by Bharatiya Nritya Raf Mandir. The topics for discussion were detailed in the September 1965 issue of the *Bulletin*. The titles of papers and other contributions submitted and selected for discussion will be announced if available in time.

History has repeatedly shown that a nation's industrial capacity determines, to a degree, its ability to survive. Agriculture has been the cornerstone of all great civilizations and irrigation one of the greatest civilizing influences. Engineering feats have aided the development of the most powerful civilizations. The story of engineering is also the story of a creative civilization bent upon knowing the unknowable, doing the impossible and taming the untamable. Engineering is the art of skilful approximation ; the practice of gamesmanship in its highest form. In the end, it is a broad enough means of combining disciplined judgment with intuition, courage with responsibility and scientific competence within the practical aspects of time, cost and talent. Present day engineering has done much to conserve time, manpower and natural resources ; to build a flourishing society and add to its productivity; to re-orient life and promote the welfare of mankind ; to raise the standards of living by providing more and better goods at less cost ; and to substitute machines for manual labour and turn nature's infinite variety into miraculous uses.

We stand at a critical juncture in our country's long range programme of economic development—a programme of rejuvenation for the attainment of a socialistic pattern of society, a programme for varied and many-sided socio-economic developments. The accomplishments of this programme in the next few years will determine the country's political future and its bearing on the future of other Asian and African countries as well. Indeed, the picture of our problems is a very mixed one. In many ways, ours is still a dual society in which an industrializing urban minority is drawing away from a stagnating traditionalist rural community. We have had nearly 20 years of systematic and constitutional development planning which has brought to us a good deal of dignity and material progress.

The developments in the technological world of tomorrow are made by the engineer of today. In his public assignments, the engineer's responsibility is enormous, his interests are to be careful, economical and efficient. He must be more than a pure technician to be truly successful, to make his contribution to the building of the human spirit. He must shoulder the burdens of an outlook that generate strength and grandeur not only in the discovery of facts but in their application ; not in receiving but in giving ; he has to continually regenerate contemporary knowledge and technical skills to bale out drudgery and insufficiency ; and he must optimize for a social end an economic and workable answer to a multivalued situation. The field of his activities is very broad—he must deal with people, directing their activities. To sum up, the engineer is both product and producer of our exciting times. It is said that the engineer is 'one who can do well with one dollar what any blunderer can do after a fashion with two'.

In the face of enemy aggression, there has arisen an emergent need for a closer coordination between the country's defence requirements and development efforts and the part the States are expected to play—an intensive defence-oriented plan based on re-allocation of priorities to ensure the maximum contribution vital to the country's defence challenge and crash programmes to attain near self-reliance and avoid dependence ; a slashing of expenditure and austerity measures in non-essential sectors of the economy, and pooling and re-modelling of the manufacturing sector with the possibility of reducing imports drastically to obtain military hardware and other material needs ; self-sufficiency in food which is no less important than an impregnable defence system for the preservation of freedom ; conservation and intelligent use of resources ; and restraint on consumption and elimination of waste to fight the new complexities that are now swiftly unfolding. Projects examination, planning and execution require regimentation and appraisals compatible with modern engineering practices and management techniques. Naturally, we cannot recur loose budgeting or infructuous expenditure or emotional and detached calculations with impunity. Our perspective has distinctly changed. It is in these that the country looks up to the engineer, the technologist and the scientist to fight the way using whatever weapons they have with ingenuity and devotion. The cause is noble and with intensive, imaginative effort, it can succeed but its success will depend, among other things, on the quality of the nation's technical talent and technological advance.

In the context of these, the theme of the Seminar is clear. It aims at an analysis of the engineer's role in redressing the imbalances in our Fourth and future Plans and the significant contribution he can make in advancing and seeing to the success of the vast human endeavours we have envisaged.

The Seminar is expected to be the broadest national forum for bringing together the many experiences of engineers—be they in private practice, public utilities, Government service, or educational field—vitally involved in the search for solutions and the creation of the necessary atmosphere wherein the seeds of new ideas are bound to germinate.

Procedure for the Seminar

A selection may first be made of the contributions that are submitted for the purpose of discussion at the Seminar. The list of contributions to be announced later may include all those received within the prescribed time limit, but it does not imply that all of them will be necessarily published. A selection will be made of the papers to be printed in the *Proceedings of the Seminar* after the Convention.

All the papers included for a Session will be first summarized by a General Reporter appointed for the purpose, and may then be thrown open for discussion after the author has introduced the paper. Authors, if allowed to reply, should limit themselves to indicate correction of errors, if any, in their paper ; to confirm additional information on the subject which was not available to them when the paper was completed ; and to reply to points raised by the General Reporter and other speakers. Only written discussions, which are received at the conclusion of a Session, will be published in the *Proceedings*.

PAPER MEETINGS OF DIVISIONS AND GROUPS

A broad programme, featuring extensive technical sessions in the seven Divisions and ten Groups of engineering which form the very core of the Institution's functional activities, has been organized. These include Paper Meetings (in two full-day sessions and one half-day session) which will present and report on papers published in the *Journal*, during the year, and offer an opportunity to survey by discussion and mutual exchange of viewpoints among members, the problems and the current trends in these fields and a basis for a more unified approach in tackling their implications in the practice of engineering.

Procedure for Paper Meetings

The Chairman of the Division/Group has absolute control over the conduct of the meeting and will open the proceedings with an Address and outline the procedure for discussion on papers. Excepting in some Groups where no papers have been published in the *Journal* and hence papers may be announced and allowed for discussion by the Chairmen on the floor of the meetings scheduled for them in the Convention programme, or informal

No. AGM 46

The Institution of Engineers (India)

8 Gokhale Road, Calcutta 20

December 8, 1965

In supersession of the Notice given in this issue of the *Bulletin* of the Forty-Sixth Annual General Meeting of the Institution of Engineers (India) to be held in the building of the Bihar Centre, Hardinge Road, Patna, which has been called on Saturday, 29th January, 1966, at 3.30 p.m., the Forty-Sixth Annual General Meeting will now be held on Sunday, 30th January, 1966, at 11.00 a.m. at the same place.

AGENDA

1. To confirm the minutes of the Forty-Fifth Annual General Meeting (circulated in the April 1965 issue of the *Bulletin* of the Institution, pages 4-31).
2. To receive the Annual Report of the Council (printed in abstract in the November 1965 issue of the *Bulletin* of the Institution, pages 1-7, and the Audited Accounts for the year ended August 31, 1965 (will follow).
3. To receive the report of the Council on the election for the session 1966-67 of (i) the President; and (ii) members of the Council.
4. To appoint Auditors for the year 1965-66 and to fix their remuneration.

B. Seshadri
Secretary

FORTY-SIXTH ANNUAL GENERAL MEETING
PATNA, JANUARY 30 — FEBRUARY 6, 1966

CHANGES AND ADDITIONAL INFORMATION

The dates of the Forty-Sixth Annual Convention have had to be revised because of circumstances beyond control from January 29-February 5, 1966, to January 30-February 6, 1966. Certain further alterations in the programme have become necessary subsequent to the printing of the approved programme, the details of which are contained in this issue of the *Bulletin*. **Members are requested to note that the Convention Programme given below supersedes that printed on pages (ii) to (vi) of this *Bulletin* and read the details of the complete programme in this changed context.**

In view of these changes it may not be possible for delegates to return the Acceptance Forms duly filled in on December 31, 1965, as indicated in these printed pages. The Bihar Centre is being requested to accept the Acceptance Forms up to January 10, 1966.

CONVENTION PROGRAMME (REVISED)

Sunday, January 30, 1966

8.30 a.m. to 1.00 p.m. 2.00 p.m. to 4.00 p.m.	Registration of local* and outstation members and visitors attending the Seminar on 'The Role of the Engineer to the Fourth Five Year Plan', at the Bihar Centre, Hardinge Road, Patna
9.30 a.m.	Meeting of the Indian National Committee for the World Power Conference at the Bihar Centre
10.00 a.m. to 10.30 a.m.	Adjourned Meeting of the 1965-66 Council at the Bihar Centre
11.00 a.m. to 12.00 noon	Business Session of the 46th Annual General Meeting at the Bihar Centre
12.00 noon to 12.15 p.m.	Tea
12.15 p.m. to 1.00 p.m.	First Session of the Seminar at the Bihar Centre
1.00 p.m. to 2.00 p.m.	Lunch

***Local members (from Patna) are requested to get themselves registered at the Bihar Centre, Hardinge Road, Patna, by January 24, 1966, the latest. Registration of local members may not be accepted after this date.**

2.30 p.m. to 5.00 p.m.	Inauguration of the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan' by Shri Ashoka Mehta, Deputy Chairman, Planning Commission, Government of India, at Bharatiya Nritya Kala Mandir
	Second Session of the Seminar at Bharatiya Nritya Kala Mandir
5.30 p.m.	A Talk on 'Bio-Engineering' by Shri J. G. Bodhe (*M.*), Member of the Council, at the Bihar Centre

Monday, January 31, 1966

9.00 a.m. to 1.00 p.m.	Registration of local and outstation members and visitors (continued) at the Bihar Centre
9.30 a.m. to 10.30 a.m.	The Ninth Sir Mokshagundam Visvesvaraya Lecture by Dr. T. Sen, Past-President, at Bharatiya Nritya Kala Mandir. Dr. K. L. Rao, Minister for Irrigation and Power, Government of India, will preside.
10.30 a.m. to 10.45 a.m.	Coffee
11.00 a.m. to 1.00 p.m.	Inauguration of the 46th Annual General Meeting at Bharatiya Nritya Kala Mandir by Shri Y. B. Chavan, Union Minister for Defence
1.00 p.m. to 2.00 p.m.	Lunch
2.00 p.m. to 4.00 p.m.	Registration of local and outstation members and visitors (continued) at Bihar College of Engineering
2.30 p.m. to 4.30 p.m.	Third Session of the Seminar at Bharatiya Nritya Kala Mandir
4.30 p.m. to 5.00 p.m.	'At Home'
6.00 p.m. to 8.00 p.m.	Variety Entertainment in aid of National Defence Fund at Bharatiya Nritya Kala Mandir

Tuesday, February 1, 1966

9.00 a.m. to 12.00 noon	Fourth and Final Session of the Seminar at Bihar College of Engineering

12.00 noon to 1.00 p.m.	Addresses by Division/Group Chairmen and Paper Meetings in Public Health Engineering Division; Mechanical Engineering Division; Industrial Engineering Group; Aeronautical Engineering Group; Chemical Engineering Division; Electronics and Telecommunication Engineering Division; and Automatic Control Group at Bihar College of Engineering
	Addresses by Chairmen* of Civil Engineering Division ; Prestressed Concrete Group; Shell Structures Group; Roads and Road Transportation Group; and Railway Engineering Group at Bihar College of Engineering
	Seminar (to be continued as necessary) at Bihar College of Engineering
1.00 p.m. to 2.00 p.m.	Lunch
2.30 p.m. to 4.00 p.m.	Paper Meetings in the above Divisions and Groups (to be continued as necessary) at Bihar College of Engineering
	Seminar (to be continued as necessary) at Bihar College of Engineering
4.30 p.m. to 6.30 p.m.	Students' Session—(1) General, and (2) Technical† at Bihar College of Engineering
	Visit to Rajgir by special train or special bus (for delegates not participating in Outstation Tours). Bath in Sulphur Springs at 7-30 p.m. Dinner at 8.30 p.m. and rest in train or Rest House
7.00 p.m. to 9.00 p.m.	Variety Entertainment in aid of National Defence Fund at Bharatiya Nritya Kala Mandir

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*Pursuant to the decision of the Third Meeting of the Civil Engineering Division Board held on December 4, 1965, regarding the procedure for holding Paper Meetings in the Civil Engineering Division and the associated Groups, *viz.*, (i) Prestressed Concrete, (ii) Shell Structures, (iii) Roads and Road Transportation, and (iv) Railway Engineering Groups, the re-arrangement as suggested by the Board are also included in this revised schedule. The Chairman of the Civil Engineering Division will decide in consultation with the Chairmen of the various associated Groups, the sequence of papers to be taken up for discussion under the Groups.

†Students desirous of presenting papers at this Session should send their manuscripts to the Headquarters Office at Calcutta not later than Friday, December 31, 1965.

Wednesday, February 2, 1966

6.30 a.m.	Leave Rajgir for Nalanda (visit to last for about two hours). Leave for Patna by special train or bus
11.00 a.m. to 1.00 p.m.	Addresses by Division/Group Chairmen and Paper Meetings in Mining and Metallurgy Division ; Petroleum Engineering Group; Electrical Engineering Division; Nuclear Engineering Group; and Marine Engineering and Shipbuilding Group at Bihar College of Engineering
	Paper Meetings in the Civil Engineering Division and associated Groups (to be continued as necessary) at Bihar College of Engineering
1.00 p.m. to 2.00 p.m.	Lunch
2.00 p.m. to 4.30 p.m.	Paper Meetings in the above Divisions and Groups (to be continued as necessary) at Bihar College of Engineering
4.30 p.m. to 5.00 p.m.	'At Home'

Thursday, February 3, 1966

9.00 a.m. to 9.30 a.m.	Meetings of Panels for Study of Engineering Subjects of Common Interest at Bihar College of Engineering
9.30 a.m. to 10.00 a.m.	Meetings of the Division Boards at Bihar College of Engineering
10.00 a.m. to 10.30 a.m.	Meeting of the Engineering Education and Research Committee at Bihar College of Engineering
9.00 a.m. to 12.00 noon	Paper Meetings (to be continued as necessary) at Bihar College of Engineering
	Seminar (to be continued as necessary) at Bihar College of Engineering
12.00 noon to 1.00 p.m.	Closing Session of the 46th Annual General Meeting at Bihar College of Engineering
1.00 p.m. to 2.00 p.m.	Lunch
2.30 p.m. to 3.30 p.m.	Meeting of the 1966-67 Council at Bihar College of Engineering

3.30 p.m. to 5.00 p.m.	Local Visits for delegates participating in Outstation Tours
7.00 p.m. to 10.00 p.m.	Commencement of Outstation Tours
Friday, February 4, 1966	
9.00 a.m. to 1.00 p.m.	Local Visits for delegates not participating in Outstation Tours
Saturday, February 5, 1966	Outstation Tours in progress
Sunday, February 6, 1966	Conclusion of Outstation Tours and dispersal

PROGRAMME OF INAUGURAL SESSION OF THE CONVENTION TO BE HELD AT PATNA, ON MONDAY, JANUARY 31, 1966

The itemized details of the Inaugural Session of the Convention to be held on Monday, January 31, 1966, are given below.

(1) 11.00 a.m. The Chief Guest, Shri Y. B. Chavan, arrives.
Introduction of the Chief Guest to the President-Elect, Shri B. P. Kapadia, and the Council, by the retiring President, Prof. N. S. Govinda Rao.
(2) 11.10 a.m. Group photograph of the Council with the Chief Guest.
(3) 11.20 a.m. Welcome Address by the Chairman of the Reception Committee.
(4) 11.25 a.m. Announcement of Prizes by the retiring President, Prof. N. S. Govinda Rao, and their award by the Chief Guest.
(5) 11.30 a.m. Conferment of Honorary Life Memberships.
(6) 11.40 a.m. Introduction of the President-Elect, Shri B. P. Kapadia, by the retiring President, Prof. N. S. Govinda Rao.
(7) 11.45 a.m. Presidential Address by Shri B. P. Kapadia.
(8) 12.20 p.m. Inaugural Address by the Chief Guest.
(9) 12.55 p.m. Vote of thanks by the Chairman of the Bihar Centre.

gatherings may be arranged to discuss topics associated with the field of engineering catered for by these Groups, a list of papers scheduled for discussion is given in the pages that follow.

Authors and participating members are specially requested to bring their own copies of the *Journal* containing the relevant papers in which they are interested.

Since most of the papers are published in the *Journal*, they are taken as read, and the author of each paper (if present in person), or the member requested by an author to present the paper on his behalf, is called upon to introduce the paper, limiting himself to its salient aspects. It is then declared open for discussion. In some cases, to accomplish concentrated interest and stimulating discussion, appointed General Reporters may be requested to summarize the papers, presenting the vital technological area covered by each, before discussion on the papers is taken up. In order to facilitate as much discussion as possible and their subsequent handling for publication in the *Journal*, those desirous of participating in them should submit in writing to the Chairman the remarks they propose to make, preferably a day prior to or at least before the commencement of the Paper Meetings.

No speaker is normally allowed to exceed the time allotted by the Chairman to him, to dilate on mere description of his work, or to divert his discussion to publicise products or services. The Paper Meetings will conclude with a summary of the proceedings by the Chairman and other announcements, if any. He may also call upon the General Reporter, if any, to sum up the discussion on the points recommended by himself.

Authors who wish to project illustrations for the purpose of introducing their papers should write to the Headquarters Office as to their requirements such as epidiascope, film projector, special and other slide projecters, etc. Effort will be made by the Bihar Centre to procure the necessary equipment for each Paper Meeting to the extent they are available in the educational and other institutions in and around Patna.

RAIL CONCESSION FOR DELEGATES

The Certificate Form for Rail Concession to delegates is attached at the end of this Programme. Members attending the 46th Annual General Meeting at Patna and desirous of availing the concession are requested to fill in and send the Form to the Secretary at the Institution Headquarters Office in Calcutta early, to get it certified.

As regards the rail concession, members will please remember that the concession will be subject to the following conditions :

(1) In the case of first class, the concessional return fare will be subject to a *minimum* of two single journey full first class fares for

400 km. ; and (ii) in the case of second and third classes, the concession will be admissible for persons travelling from beyond 400 km. from the place of the meeting without any minimum fare.

(2) The concession is available only for to and fro journey by the shortest route between the railway station where the journey commences and Patna.

(3) The concession is available only to the member's person, and cannot be extended to his lady or family.

(4) The Railway Board have authorized only the Secretary to issue the Certificate.

(5) The Railway Board require that a Letter of Authority should first be obtained from an authorized Officer of the Railways, who is generally the Chief or District or Divisional Commercial Superintendent, which should be produced to the Station Master of the Railway Station where the journey commences. *Members resident at small stations are particularly invited to note this as the Station Masters themselves are not authorized to admit the concession.*

(6) The Railway Board require that the Institution should submit a statement after the Annual General Meeting, as to how many members availed themselves of the concession. **The continuance of the concession is dependant on the submission of this statement to the Board.** Members are, therefore, requested to (a) fill in the slip attached to the Certificate Form and return it to the Headquarters after the Annual General Meeting ; and also (b) to state if they availed of the concession in the special column which will be provided by the Bihar Centre in the Registration Books at Patna. **These two requirements are most important.**

(7) The certificate is not issued to those whose travelling expenses are borne by the Central/State Government or a local body or a Statutory authority.

(8) The concession is admissible only to persons travelling from beyond 400 km. from the place of the Convention.

GENERAL INFORMATION FOR DELEGATES AND PARTICIPANTS

1. Registration of Delegates and Guests

Registration of local and outstation members and visitors attending the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan' will commence on Saturday, January 20, 1966, at the Bihar Centre at 8.30 a.m.

and continue up to 1.00 p.m. and again from 2.00 p.m. to 4.00 p.m. For the convenience of delegates and accompanying guests who may arrive later, the registration counters will also be open on Sunday, January 30, 1966, at the Bihar College of Engineering, Patna, from 9.00 a.m. to 1.00 p.m. and 2.00 p.m. to 4.00 p.m.

Local Members (from Patna) are specially requested to get themselves registered at the Bihar Centre on January 24, 1966, the latest.

Delegates planning to attend the Convention are requested to ensure in their own interest that the Acceptance Forms complete in every respect and the necessary remittances are received by the Bihar Centre **latest by December 31, 1965.** The Registration Fee is :

For Corporate Members and Graduates	..	Rs. 15.00 per person
For Students	..	Rs. 10.00 per student

2. General Transport

A consolidated charge of Rs. 10.00 will have to be paid by each delegate wishing to avail of the transport facility to be provided by the Bihar Centre during the Convention. This amount does not include the charge for Local Visits, but covers conveyance from railway station to place of lodging and from place of lodging to places where technical meetings and programmes of social and cultural entertainment are held during the Convention.

3. Local Visits and Outstation Tours

Interested delegates must indicate their first choice of the tour (and also an alternative choice) and remit in advance the full amount fixed for each tour. The amount payable is as under :

For Local Visits	..	Rs. 5.00 per delegate per visit
For Outstation Tour	..	Rs. 115.00 per delegate for Tours 1 to 4 and Rs. 23.00 per delegate for Tour 5

4. Arrangements for Return Journey

Reservation for the return journey for the delegates and accompanying persons may be arranged, if the exact date of departure to their places of destination is intimated sufficiently in advance. Local travel agents will be in charge of these arrangements and they will charge their usual service fee of Rs. 5.00 for attending to this facility.

5. Ladies' Programme

A separate programme for ladies accompanying members is also being planned and will be organised only if the number of participants justifies it. A Registration Fee of Rs. 10.00 per lady will have to be remitted by the delegate if the lady/ladies accompanying him desire to participate in the Ladies' Programme. This registration will enable them to attend the social functions during the Convention, including the special visits and conducted shopping tours that may be arranged for ladies, but excluding the Outstation Tour. The detailed programme in respect of these will be notified during the Convention.

GRANT OF CASUAL LEAVE FOR GOVERNMENT OFFICERS ATTENDING MEETING OF SCIENTIFIC ASSOCIATIONS

An extract from Notification No. 74 (4)/-50-SR.III, dated July 29, 1951, printed in the *Bulletin*, vol. 1, no. 1, September 1951, p. 28, and Notification No. 227 (7)/-53-SR.III, dated December 10, 1953, printed in the *Bulletin*, vol. 3, no. 3, March 1954, p. 14, issued by the Ministry of Natural Resources and Scientific Research, Government of India, in regard to the grant of casual leave to such officers as desire to attend meetings of scientific associations is reproduced below for information :

'.................... subject to the exigencies of Government business, Government servants who are invitees, members, official delegates to the organization concerned or have been asked to read papers at a conference may be given facilities to attend meetings organized by scientific associations like The Indian Science Congress Association, The National Institute of Science of India, The Institution of Engineers (India), The Indian Academy of Sciences, Bangalore, and other similar bodies, by the grant to them of special casual leave to the extent required for attendance at the meetings and for journeys to and from the places of meeting. It is requested that if there is no objection, requests from individual Government servants for leave to attend meetings of scientific associations may be disposed of in the light of this decision'.

DELEGATE ACCOMMODATION

Patna has just one large Western style hotel. Hotel accommodation, especially for a gathering of our largeness, is rather short. Provision is being made to accommodate the delegates in all the available hotels listed in the following pages. Their address, style, rates, telephone number, etc. are also furnished to assist the delegates in the selection and reservation of accommodation of their choice well ahead, so to avoid last minute disappointments.

Members are therefore particularly requested to remit the hotel charges as early as possible, but, at any rate, as to reach **not later than December 31, 1965,** to the Honorary Secretary, Bihar Centre, The Institution of Engineers (India), Hardinge Road, Patna, for the number of days for which accommodation is desired, specifying the name of the hotel. Accommodation will be necessarily allotted strictly in the order of priority of applications received and no accommodation can be assured on applications received late. It is advisable that members furnish an alternative choice of accommodation, to ensure that in case their first choice is not available, it is possible to offer them alternative accommodation.

HOTELS AND OTHER FACILITIES IN PATNA

Members are requested to select their hotel accommodation from the list below and also furnish an alternative choice. The full amount in respect of the accommodation for the number of days desired should be remitted to the **Honorary Secretary, Bihar Centre, The Institution of Engineers (India), Hardinge Road, Patna**, as early as possible, but, in any case, **not later than December 31, 1965**, specifying the name of the hotel.

Accommodation at	Number of rooms		Rate per day		With or without food	Type of food available if required	Advance notice for reservation	Amenities/Remarks
	Single	Double	Single room	Double-room				
A Class **Hotel Republic** Brijkishore Path (Exhibition Road) *Telephone* 22028	15	22 (and 2 suites)	Rs. 31 to Rs. 35	Rs. 42 to Rs. 52	Without food	Serves vegetarian and non-vegetarian food	30 days	Attached bath, hot and cold water showers, telephone in room, and air-conditioned rooms
Grand Hotel Mazharul Haque Path (Fraser Road) *Telephone* 22798	5	3	Rs. 11 to Rs. 19	Rs. 21 to Rs. 30	— With and without food	Serves vegetarian and non-vegetarion food	7 days	Attached bath (the rates Rs. 19 and Rs. 30 are with food and the rates Rs. 11 and Rs. 21 without food)
Palace Hotel Opposite Gandhi Maidan *Telephone* 26364	5	25	Rs. 12	Rs. 22 to Rs. 32 (air-conditioned)	Without food but inclusive of bed tea and afternoon tea	Serves non-vegetarain food only	30 days	Attached bath and telephone in room

HOTELS AND OTHER FACILITIES IN PATNA—Contd.

Accommodation at	Number of rooms		Rate per day		With or without food	Type of food available if required	Advance notice for reservation	Amenities/Remarks
	Single	Double	Single room	Double-room				
Hotel Natraj Ashok Path *Telephone* 25662	11	17	Rs. 6 to Rs. 8 Rs. 20	Rs. 10 to Rs. 12 Rs. 15 to Rs. 18 Rs. 25	Without food	Serves both vegetarian and non-vegetarian food	30 days	Telephone in room (single rooms at Rs. 6 are without attached bath, those at Rs. 8 are with attached bath and those at Rs. 20 are air-conditioned ; similar double rooms are also available)
Rajasthan-Hotel Fraser Road *Telephone* 26019	4	7	Rs. 7 to Rs. 18 (air conditioned)	Rs. 30	Without food	Serves vegetarian food only	14 days	Attached bath and telephone in room
Circuit House *Telephone* 22305				Rs. 8 (per head) to Rs. 12 (for a family)	Without food	Serves food on request		Attached bath, only limited accommodation available
B Class **Marwari Hotel** Mazharul Haque Path (Fraser Road) *Telephone* 22481	8	—	Rs. 7	—	Without food	Serves vegetarian food only	7 days	Attached bath and telephone in room

HOTELS AND OTHER FACILITIES IN PATNA—Contd.

Accommodation at	Number of rooms		'Rate per day		With or without food	Type of food available if required	Advance notice for reservation	Amenities/Remarks
	Single	Double	Single room	Double-room				
Prince Hotel Mazharul Haque Path (Fraser Road) *Telephone* 22643	5	2	Rs. 4 to Rs. 10	Rs. 10 to Rs. 16	Without food	Serves vegetarian and non-vegetarian food	7 days	Some rooms with attached bath and common telephone
Central Hotel Opposite Gandhi Maidan *Telephone* 23251	5	—	Rs. 6	—	Without food	Serves vegetation and non-vegetarian food	7 days	Common bath and common telephone
Hotel Anand Bhavan Mazharul Haque Road (Fraser Road) *Telephone* 25463	6	6 (and 2 special rooms)	Rs. 4	Rs. 6 and Rs. 10 (for special rooms)	Without food	Serves vegetarian food only	7 days	Double-rooms with attached bath and single rooms with common bath (only 6 rooms available for reservation)
Hotel Shri Prakash Mazharul Haque Path (Fraser Road) *Telephone* 25823	22	6	Rs. 6 to Rs. 8	Rs. 6 to Rs. 10	Without food	Serves vegetarian food only	21 days	Some rooms with attached bath and common telephone (only half the number of rooms available for reservation)
New Patna Hotel Rajendra Path (Station Road) *Telephone* 26213	16	6	Rs. 3 to Rs. 4	Rs. 8 to Rs. 10	Without food	Serves vegetarian and non-vegetarian food	7 days	Common bath and common telephone

HOTELS AND OTHER FACILITIES IN PATNA—Contd.

Accommodation at	Number of rooms		Rate per day		With or without food	Type of food available if required	Advance notice for reservation	Amenities/Remarks
	Single	Double	Single room	Double-room				
Hotel Mansarovar Rajendra Path (Station Road) *Telephone* 23811	15	2	Rs. 2.50 Rs. 3 Rs. 4	Rs. 5	Without food	Serves vegetarian food only	7 days	Common bath and common telephone
New Agarwal Hotel Rajendra Path *Telephone* 24919	10	18	Rs. 2.50 Rs. 3	Rs. 4.50 Rs. 5 Rs. 8	Without food	Serves vegetarian food only	7 days	Four rooms with attached bath
Agarwal Hotel Station Road *Telephone* 22799	10	—	Rs. 4 to Rs. 7	—	Without food	Serves vegetarian food only	14 days	Common bath and common telephone
Bharatiya Niwas Hotel Station Road	22	8	Rs. 4	Rs. 5 to Rs. 6	Without food	Serves vegetarian and non-vegetarian food	7 days	Common bath for single rooms, and attached bath for double rooms, and no telephone
Hotel Pradeep Bhawan Frazer Road	10	12	Rs. 4	Rs. 6 Rs. 8 Rs. 12	Without food	Serves vegetarian food only	7 days	Only 14 room with attached bath available for reservation. Common bath for single rooms. No telephone
Bharat Coffee House Frazer Road *Telephone* 26453	2	2	Rs. 4	Rs. 6	Without food	Serves vegetarian food only	7 days	Common bath
Kosi Rest House *Telephone* 23342	—	—		Rs. 5 (per person)	Without food	Serves food on request	—	Attached bath, only limited accommodation available

HOTELS AND OTHER FACILITIES IN PATNA—Contd.

Accommodation at	Number of rooms		Rate per day		With or without food	Type of food available if required	Advance notice for reservation	Amenities/Remarks
	Single	Double	Single room	Double-room				
Dak Bangalow				Rs. 7.50 (for family)	Without food	—	—	
C Class **Raj Hotel** Rajendra Path Kadam Kuan *Telephone* 23713	7	3	Rs. 3.50	Rs. 5	Without food	Serves vegetarian food only	10 days	Common bath
Rabindra Hotel Pirmohani *Telephone* 26154	4	12	Rs. 2.50	Rs. 5 to Rs. 7	Without food	Serves vegetarian food only	15 days	Some double-rooms with attached bath
Janpath Hotel Kadam Kuan *Telephone* 22927	5	5	Rs. 3	Rs. 4	Without food	Serves vegetarian and non-vegetarian food	10 days	Common bath
Janta Hotel Govind Mitra Road *Telephone* 23343	2	3	Rs. 2.50	Rs. 3	Without food	Serves vegetarian and non-vegetarian food	7 days	Commode system
Officers' Flat			Rs. 5	Rs. 10 (suite of two rooms)	Without food	—	—	Limited accommodation available, common bath per suite of two rooms
Engineering College Hostel	60	120	Rs. 4.50	Rs. 3 (per seat)	Without food			Common bath

LOCAL VISITS

Local Visits are also being arranged for delegates during the Convention, on 2nd February for those who are participating in the Outstation Tours and on 3rd February for those not participating in the Outstation Tours. Since the number of delegates who can participate in each visit has to be necessarily limited, delegates will have to indicate their first choice and an alternative choice also, if necessary, when the programme of Local Visits is announced at the time of the Convention.

A short excursion to Rajgir and Nalanda has been planned on January 30-31, 1966, for delegates not participating in Outstation Tours.

OUTSTATION TOURS

Five alternative post-Convention Outstation Tours within Bihar are being organized subject to sufficient response from the delegates. For organizational reasons, it would be necessary to restrict the number of delegates that can be accommodated in each tour depending on the housing, transport and other conveniences, and hence it is urged that advance registration is very necessary. Delegates who desire to join these tours may select any one of them most convenient to their own schedule. The names of participants will be registered only on receipt of full payment of the charges fixed for each tour, that is, Rs. 115.00 per member, for 1 to 4 and Rs. 23 per member for Tour 5. Delegates are requested to inform the Honorary Secretary, Bihar Centre, of their first choice of the tour in which they wish to participate (and also an alternative choice) on or before December 31, 1965. Registration for the tours will be filled in the order in which they are received. The delegates are advised to bring their own bedding, warm clothing, etc. for the tour.

All these tours will commence on the evening of Wednesday, February 2, 1966, from Patna Railway Station and will conclude on Saturday, February 5, 1966, at the last place mentioned in each tour.

Delegates participating in the Outstation Tours should please note that in case they wish to avail of the rail concession for the return journey, they will have to travel back to Patna on their own, irrespective of whether the railway station where each tour terminates is or is not on the route by which the rail concession is granted to the delegates, as this concession is not admissible from an intermediate station and is valid from Patna only for the return journey.

The itineraries of the tours, are detailed below.

TOUR 1: PATNA—RAJGIR—BODH GAYA—PATRATU—RANCHI

Date	Departure	Arrival	Miles/ Transport	Sites of interest
Wednesday, February 2, 1966	23.0 p.m. Patna	Rajgir 6.30 p.m.	64/Bus	Nalanda Excavations, Monasteries; Hot Springs, etc.
	Dinner and halt at Rajgir for the night.			
Thursday, February 3, 1966	8.00 p.m. Rajgir	Bodh Gaya 10.00 a.m.	50/Bus	Mahabodhi Temple; Monasteries; Archaeological Museum
	11.00 a.m. Bodh Gaya	Hazaribagh National Park 1.30 p.m.	64/Bus	National Park
	Lunch at National Park			
	4.00 p.m. National Park	Patratu 6.30 p.m.	59/Bus	
	Dinner and halt at Patratu for the night.			
Friday, February 4, 1966	11.00 a.m. Patratu	Ranchi 1.30 p.m.	47/Bus	Patratu Thermal Power Station; Heavy Engineering Corporation; Namkum Lac Research Institute; High Tension Insulator factory etc.
	Lunch and Dinner at Ranchi and halt at Ranchi for the night.			
Saturday, February 5, 1966	At Ranchi			
	Dispersal from Ranchi at 5.00 p.m.			

Note **: Visits to factories, etc. will be subject to grant of permission. This applies to all the tours.**

TOUR 2 : PATNA—DHANBAD—JAMSHEDPUR

Date	Departure	Arrival	Miles/ Transport	Sites of interest
Wednesday, February 2, 1966	9.15 p.m. Patna		Train	
Thursday, February 3, 1966		Dhanbad 7.07 a.m.		Central Fuel Research Institute; Fertilizer Factory; Coal Washery; Central Mining Research Institute; Superphosphate Factory, etc.
	Halt at Dhanbad for the night.			
Friday, February 4, 1966	8.00 a.m. Dhanbad	1.00 p.m.	108/Bus	Tata Iron and Steel Co. Ltd.; Tata Engineering and Locomotive Co., Ltd.; Tinplate Co. of India, Ltd.; Indian Hume Pipe Co., Ltd.; National Metallurgical Laboratory, etc.
	Halt at Jamshedpur for the night.			
Saturday, February 5, 1966	At Jamshedpur			
	Dispersal from Jamshedpur at 5.00 p.m.			

TOUR 3: PATNA—RANCHI—DHANBAD

Date	Departure	Arrival	Miles/ Transport	Sites of interest
Wednesday, February 2, 1966	9.15 p.m. Patna		Train	
Thursday February 3, 1966		Ranchi 8.20 a.m.		Heavy Engineering Corporation; Namkum Lac Research Institute; High Tension; Insulator Factory, etc.
	Halt at Ranchi for the night.			

TOUR 3—*Contd.*

Friday, February 4, 1966	8.00 a.m. Ranchi	Dhanbad 1.30 p.m.	131/Bus	Hundroo Falls ; Fertilizer Factory; Coal Mines at Sudamdih; Central Fuel Research Institute Coal Washery ; Central Mining Research Institute ; Superphosphate Factory, etc.
	Lunch at Dhanbad.			
	Halt at Dhanbad for the night.			
Saturday, February 5, 1966	At Dhanbad			
	Dispersal from Dhanbad at 5.00 p.m.			

TOUR 4: PATNA—DEHRI-ON-SONE—BODH GAYA—RAJGIR—PATNA

Date	Departure	Arrival	Miles/ Transport	Sites of interest
Wednesday, February 2, 1966	2.45 p.m. Patna	Dehri-on-Sone 7.00 p.m.	110/Bus	-
	Halt at Dehri-on-Sone for the night.			
Thursday February 3, 1966	At Dehri-on-Sone			Sone Barrage; Sone Bridge; Sahu Jain Industries
	Halt at Dehri-on-Sone for the night.			
Friday, February 4, 1966	8.30 am. Dehri-on-Sone	Bodh Gaya 10.30 a.m.	62/Bus	Mahabodhi Temple ; Monastries ; Archeological Museum
	11.30 a.m. Bodh Gaya	Rajgir 1.30 p.m.	50/Bus	Hot springs ; Monastries, etc.
	Lunch at Rajgir. Dinner and halt at Rajgir for the night.			
Saturday, February 5, 1966	9.30 a.m. Rajgir	Patna 1.30 p.m.	64/Bus	Nalanda Excavations ; Monastries, etc.
	Lunch at Patna.			
	Dispersal from Patna 5.00 p.m.			

TOUR 5: PATNA—BARAUNI—PATNA*

Date	Departure	Arrival	Miles/ Transport	Sites of interest
Thursday, February 3, 1966	8.00 a.m. Patna	Barauni 10.30 a.m.	75/Bus	Indian Refinery; Thermal Power Station
	Lunch at Indian Oil Refinery.			
	4.30 p.m. Barauni	Patna 7.00 p.m.	75/Bus	
	Dispersal from Patna at 7.00 p.m.			

**Note* : This short tour will be arranged if there is adequate response from delegates.

SPECIAL TOUR: PATNA-RAJGIR-PATNA

Date	Departure	Arrival	Miles/ Transport	Sites of interest
Monday, January 31, 1966	4.30 p.m. Patna	**Rajgir** 7.30 p.m.	64/Bus/Train	Hot Springs; monasteries.
	Dinner and halt at Rajgir for the night.			
Tuesday, February 1, 1966	6.30 a.m. Rajgir	10.30 a.m. Patna	64/Bus/Train	Nalanda excavations; monasteries.

TIME-TABLE FOR PAPER MEETINGS OF DIVISIONS AND GROUPS AND SEMINAR ON 'THE ROLE OF THE ENGINEER IN THE FOURTH FIVE YEAR PLAN', JANUARY 29 TO FEBRUARY 2, 1966

To aid ready reference, the time-tables for the Paper Meetings and the Seminar are given below. The papers listed for discussion in the Paper Meetings are given in the following pages of this *Bulletin* and those to be presented at the Seminar will be announced later.

PAPER MEETINGS

Paper Meetings	Time-schedule for		
	Monday, January 31, 1966	Tuesday, February 1, 1966	Wednesday, February 2, 1966
Public Health Engineering Division	FIRST SESSION 12.00 noon to 1.00 p.m. and 2.30 p.m. to 4.30 p.m.		THIRD SESSION 9.00 a.m. to 12.00 noon Paper Meeting to be continued as necessary.
Prestressed Concrete Group			
Shell Structures Group			
Mechanical Engineering Division Industrial Engineering Group Aeronautical Engineering Group			
Chemical Engineering Division			
Electronics and Telecommunication Engineering Division Automatic Control Group			
Hindi Section			
Civil Engineering Division Roads and Road Transportation Group		SECOND SESSION 11.00 a.m. to 1.00 p.m. and 2.00 p.m. to 4.30 p.m.	THIRD SESSION 9.00 a.m. to 12.00 noon Paper Meeting to be continued as necessary
Railway Engineering Group			
Mining and Metallurgy Division Petroleum Engineering Group			
Electrical Engineering Division Nuclear Engineering Group			
Marine Engineering and Shipbuilding Group			

SEMINAR

Saturday, January 29, 1966	9.30 a.m. to 11.45 a.m. 12.00 noon to 1.00 p.m.	First Session Second Session
Sunday, January 30, 1966	2.30 p.m. to 4.30 p.m.	Inaugural Session and Third Session
Monday, January 31, 1966	9.00 a.m. to 11.45 a.m. 12.00 noon to 1.00 p.m. 2.30 p.m. to 4.00 p.m.	Fourth and Final Session Seminar to be continued as necessary
Wednesday February 2, 1966	9.00 a.m. to 12.00 noon	Seminar to be continued as necessary

FIRST SESSION : MONDAY, JANUARY 31, 1966 : **12.00 noon to 1.00 p.m.**
2.30 p.m. to 4.30 p.m.

SCHEDULE FOR PAPER MEETINGS OF DIVISIONS AND GROUPS

The papers scheduled for Paper Meetings in each of the following Divisions and Groups are shown serially under one session only. The actual allocation of papers for the First Session, and the Third Session, *i.e.*, the common Session to all Divisions and Groups to be continued on Wednesday, February 2, 1966, between 9.00 a.m. to 12.00 noon (if necessary), will be announced by the respective Division and Group Chairmen at the First Session on January 31, 1966.

Public Health Engineering Division

(1) Address by Shri S. K. Majumder (*M.*), *Chairman*

(2) 'Studies on River Pollution—1 : Pollution and Self-Purification of Gomati River near Lucknow' by T. R. Bhaskaran (*Non-member*), R. N. Chakrabarty (*Non-member*) and R. C. Trivedi (*Non-member*) (*Journal*, vol. 45, no. 6, pt. PH 2, February 1965)

(3) 'Comparative Study of *MF* Technique and *MPN* Procedure' by R. L. Gandhi (*Non-member*) and M. Chandra (*A.M.*) (*Journal*, vol. 45, no. 6, pt. PH 2, February 1965)

(4) 'Basic Mechanisms in the Anaerobic Digestion of Sewage Sludge' by Dr. B. B. Sundaresan (*A.M.*) (*Journal*, vol. 45, no. 6, pt. PH 2, February 1965)

(5) 'Stream Capacity Constants of Adyar River' by Dr. B. B. Sundaresan (*A.M.*) (*Journal*, vol. 45, no. 10, pt. PH 3, June 1965)

(6) 'Conditioning Tannery Waste for Biological Treatment' by C. P. Thambiannan (*Non-member*) and T. K. Meenakshisundaram (*Non-member*) (*Journal*, vol. 45, no. 10, pt. PH 3, June 1965)

Prestressed Concrete Group

(1) Address by Shri K. F. Antia (*M.*), *Chairman*

(2) 'Approximate Solution of Simply Rectangular Plates of Varying Thickness' by Dr. P. Desayi (*A.M.*) (*Journal*, vol. 45, no. 9, pt. CI 5, May 1965)

(3) 'Plastic Design of Reinforced Concrete Slabs' by Dr. R. Narayanaswamy (*A.M.*) (*Journal*, vol. 45, no. 9, pt. CI 5, May 1965)

(4) 'Carryover and Stiffness Factors of a Two-Way Slab' by Dr. P. Dayaratnam (*A.M.*) (*Journal*, vol. 45, no. 11, pt. CI 6, July 1965)

(5) 'Effects of Transversals in T-Beam and Slab Bridges' by Brajendra Kumar (*Non-member*) (*Journal*, vol. 46, no. 3, pt. CI 2, November 1965)

(6) 'Large Deflections of Cantilevers by Relaxation Method' by Dr. P. Desayi (*A.M.*) (*Journal*, vol. 46, no. 3, pt. CI 2. November 1965)

(7) 'Linear Graph Theory Applied to Structures—1 : Continuous Beams' by P. S. Satsangi (*Non-member*) and V. K. Garg (*Non-member*) (*Journal*, vol. 46, no. 3, pt. CI 2, November 1965)

Shell Structures Group

(1) Address by Shri G. S. Ramaswamy (*M.*), *Chairman*

(2) 'Grid Analysis by Iteration Method' by M. G. Tamhankar (*Non-member*) (*Journal*, vol. 45, no. 5, pt. CI 3, January 1965)

(3) 'Buckling of Funicular Shell of Square Plan' by Dr. P. Dayaratnam (*Non-member*) (*Journal*, vol. 45, no. 7, pt. CI 4, March 1965)

(4) 'Deflection of Funicular Shell Square in Plan by Strain Energy Method' by P. Dayaratnam (*A.M.*) (*Journal*, vol. 46, no. 3, pt. CI 2, November 1965)

(5) 'Computer Analysis of Folded Plates by the Method of Transfer Matrices' by M. Ramaiah (*A.M.*) (*Journal* vol. 46, no. 3, pt. CI 2, November 1965)

Mechanical Engineering Division

(1) Address by Shri T. R. Gupta (*M.*), *Chairman*

(2) 'Photo-Elastic Investigation on the Compatibility of Force System in Chip Formation' by Dr. A. Bhattacharyya (*A.M.*) and A. Ghosh (*Non-member*) (*Journal*, vol. 45, no. 5, pt. ME 3, January 1965)

(3) 'Kinematic Analysis of Cam Mechanisms' by S. V. Kulkarni (*A.M.*) (*Journal*, vol. 45, no. 7, pt. ME 4, March 1965)

(4) 'Effectiveness of Fuel Cetane Number for Combustion Control in Bi-Fuel Diesel Engine' by B. S. Murthy (*A.M.*) and L. G. Pless (*Non-member*) (*Journal*, vol. 45, no. 7, pt. ME 4, March 1965)

(5) 'Economics of Metal Cutting' by K. C. Sahu (*Non-member*) and S. K. Basu (*A.M.*) (*Journal*, vol. 45, no. 7, pt. ME 4 March 1965)

(6) 'Vibration of Beams with Variable Stiffness' by Dr. P. Dayaratnam (*Non-member*) (*Journal*, vol. 45, no. 9, pt. ME 5, May 1965)

(7) 'Observations on Fixed Roots of Chips During High Speed Machining' by G. R. Ponkshe (*Non-member*) (*Journal*, vol. 45, no. 9, pt. ME 5, May 1965)

(8) 'Optimum Pressure Ratio in a Multistage Reciprocating Compressor' by M. S. Keshav (*Non-member*) and R. N. Reddy (*Non-member*) (*Journal*, vol. 45, no. 11, pt. ME 6, July 1965)

(9) 'Preloading of Bearing in a Machine Tool' by G. Mitra (*Non-member*) and Dr. S. K. Basu (*A.M.*) (*Journal*, vol. 45, no. 11, pt. ME 6, July 1965)

(10) 'Noise Control in Air-Conditioning Systems' by T. L. Sitharama Rao (*Non-member*) and Dr. S. V. Narasimhan (*Non-member*) (*Journal*, vol. 45, no. 11, pt. ME 6, July 1965)

(11) 'Temperature of Carbon and Engine Deposits' by Dr. B. S. Chittawadgi (*Non-member*) and Prof. A. N. Voinov (*Non-member*) (*Journal*, vol. 46, no. 1, pt. ME 1, September 1965)

(12) 'Machinability of Materials Difficult to Machine' by Prof. V. V. Tsotskhadze (*Non-member*) (*Journal*, vol. 46, no. 1, pt. ME 1, September 1965)

(13) 'Supercharging of I.C. Engines for Power Loss Compensation at High Altitudes' by K. P. Singh (*Non-member*) (*Journal*, vol. 46, no. 3, pt. ME 2, November 1965)

(14) 'Machining of Chip Breakers' by T. L. Subramaniaml(*Non-member*) and Dr. A. Bhattacharyya (*A.M.*) (*Journal*, vol. 46, no. 3, pt. ME 2, November 1965)

(15) 'Manufacture of Diesel Locomotives in India' by V. A. Patel (*A.M.*) (*Journal*, vol. 46, no. 3, pt. ME 2, November 1965)

Industrial Engineering Group

(1) Address by Shri R. M. Patre (*M.*), *Chairman*

(2) 'High Intensity Industrial Noises' by S. K. Asthana (*Non-member*) and V. Narasimhan (*Non-member*) (*Journal*, vol. 45, no. 9, pt. ME 5, May 1965)

(3) 'Network Management Techniques' by Prof. B. S. Rao (*A.M.*) (*Journal*, vol. 46, no. 1, pt. ME 1, September 1965)

Aeronautical Engineering Group

The Chair of the Aeronautical Engineering Group is vacant at present and there are no papers for discussion in this Group.

Chemical Engineering Division

(1) 'Coal Washeries in India with Special Reference to Civil Engineering Aspects' by S. M. Guha Biswas (*A.M.*) (*Journal*, vol. 45, no. 6, pt. CH 2, February 1965)

(2) 'Thermal Conductivity of Indian Thermal Insulating Materials at Medium Temperature' by T. D. Bansal (*Non-member*) and V. P. Wasan (*Student*) (*Journal*, vol. 45, no. 10, pt. CH 3, June 1965)

(3) 'Human Factors in Interplanetary Flight' by Prof. S. K. Nandi (*Non-member*) (*Journal*, vol. 45, no. 10, pt. CH 3, June 1965)

(*Chair vacant at present*)

Electronics and Telecommunication Engineering Division

(1) Address by Brig. M. K. Rao (*M.*), *Chairman*

(2) 'Transistorized Definite Time-Lag Relay Using Constant Current Charging Source' by S. K. Basu (*Non-member*) (*Journal*, vol. 45, no. 5, pt. ET 2, January 1965)

(3) 'Microwave Spectrometer' by M. M. Rao (*Non-member*) and S. K. Chatterjee (*Non-member*) (*Journal*, vol. 45, no. 5, pt. ET 2, January 1965)

(4) 'Design of Electron Optical Systems for Collimators and Deflectors' by C. S. Upadhyay (*Non-member*) (*Journal*, vol. 45, no. 5, pt. ET 2, January 1965)

(5) 'Simulation of Fourth Order Systems with Double Lead by Single Operational Amplifier' by L. K. Wadhwa (*Non-member*) and Maj. S. P. Sharma (*A.M.*) (*Journal*, vol. 45, no. 5, pt. ET 2, January 1965)

(6) 'Design and Application of Transistorized Phase Angle Meter' by S. K. Basu (*Non-member*), Dr. S. P. Patra (*A.M.*) and Prof. J. K. Choudhury (*A.M.*) (*Journal*, vol. 45, no. 9, pt. ET 3, May 1965)

(7) 'Party Line Telephone Working Using a New Device' by P. N. Das (*Non-member*) (*Journal*, vol. 45, no. 9, pt. ET 3, May 1965)

(8) 'Near End Infa-Red Filters for I. R. Communication Systems' by K. R. Wadhera (*Non-member*) (*Journal*, vol. 45, no. 9 pt. ET 3, May 1965)

(9) 'One Amplifier Simulation of Third Order Systems' by G. K. Aggarwal (*Non-member*) (*Journal*, vol. 46, no. 1, pt. ET 1, September 1965)

(10) 'Classification of Modes in Electromagnetic Waveguides' by S. K. Chatterjee (*Non-member*) (*Journal*, vol. 46, no. 1, pt. ET 3, September 1965)

Automatic Control Group

(1) Address by Prof. V. V. Sarwate (*M.*), *Chairman*

(*Details to be announced at the meeting*)

Hindi Section

(1) Address by Shri Brijmohanlal (*M.*), *Adviser*,

(2) 'Stress Distribution in Gear Teeth' by C. B. Mishra (*Graduate*) (*Journal*, vol. 45, no. 4, pt. HI 1, December 1964)

(3) 'Earthern Sides for Roof' by G. C. Mathur (*Non-member*) (*Journal*, vol. 45, no. 4, pt. HI 1, December 1964)

(4) 'Relationship between the Size of the Foundation Models and Size of the Tank in which Experiments are performed in Soil Mechanics' by Dr. Janardan Jha (*A.M.*) (*Journal*, vol. 45, no. 8, pt. HI 2, April 1965)

(5) 'Science in Building' by Rabinder Singh (*Non-member*) and G. C. Mathur (*Non-member*) (*Journal*, vol. 45, no. 8, pt. HI 2, April 1965)

(6) 'Problem of Temperature in Metal Cutting' by C. B. Mishra (*Graduate*) (*Journal*, vol. 45, no. 12, pt. HI 3, August 1965)

SECOND SESSION : TUESDAY FEBRUARY 1, 1965 : 11.00 a.m. to 1.00 p.m.
2.00 p.m. to 4.30 p.m.

The papers scheduled for the Paper Meetings in each of the following Divisions and Groups are shown serially under one session only. The actual allocation of papers for the Second Session, and the Third Session, *i.e.*, the common Session to all Divisions and Groups to be continued on Wednesday, February 2, 1966, between 9.00 a.m. to 12.00 noon (if necessary), will be announced by the respective Division or Group Chairmen at the Second Session on February 1, 1966.

Civil Engineering Division

(1) Address by Shri K. K. Nambiar (*M.*), Chairman

Hydraulics and Irrigation

(2) 'Plugging of Right Diversion Tunnel after Failure of Hoist Chamber at Bhakra Dam' by Dr. H. L. Uppal (*M.*), T. D. Gulati (*Non-member*) and Gajinder Singh (*Non-member*) (*Journal*, vol. 45, no. 5, pt. CI 3, January 1965)

(3) 'Design of Bidyadharpur Barrage' by K. C. Das (*M.*) (*Journal*, vol. 45, no. 11, pt. CI 6, July 1965)

Structural

(4) 'Disastrous Building Collapse at Yeotmal—Engineering Analysis of a Serious Construction Failure' by D. R. Dalvi (*M.*) and M. M. Inamdar (*A.M.*) (*Journal*, vol. 45, no. 7, pt. CI 4, March 1965)

(5) 'Earthquake Resistant Design of Buildings' by Dr. Jai Krishna (*M.*) and Dr. A. S. Arya (*Non-member*) (*Journal*, vol. 45, no. 7, pt. CI 4, March 1965)

Bridges and Roads

(6) 'Well Sinking in Gowtami Bridge Construction' by T. Achyuta Ramayya (*A.M.*) (*Journal*, vol. 45, no. 7, pt. CI 4, March 1965)

(7) 'Pneumatic Sinking of Well in North Koel Bridge Foundation' by Vijaya Singh (*Non-member*) (*Journal*, vol. 46, no. 1, CI 1, September 1965)

Foundation Engineering

(8) 'Clay Grouting of Foundation at Kotah Barrage, Chambal Project, Rajasthan' by A. S. Kapoor (*A.M.*) (*Journal*, vol. 45, no. 5, pt. CI 3, January 1965)

Miscellaneous

(9) 'An Application of Critical Path Method for Construction Planning' by C. B. Patel (*A.M.*) (*Journal*, vol. 46, no. 1, pt. CI 1, September 1965)

Roads and Road Transportation Group

(1) Address by Shri K. K. Nambiar (*M.*), *Chairman*

(2) 'Contact Stress between Bullock Cart Tyre and Road Surface' by Y. C. Gokhale (*A.M.*) and R. S. Mehta (*Student*) (*Journal*, vol. 45, no. 11, pt. CI 6, July 1965)

(3) 'Planning of Highway System in Assam' by G. C. Sharma (*M.*) (*Journal*, vol. 45, no. 1, pt. CI 1, September 1965)

(4) 'Urban Transportation' by P. G. Patankar (*A.M.*) (*Journal*, vol. 46, no. 3, pt. CI 2, November 1965)

(5) 'Drawbacks of Bituminous Mix Design Methods' by M. V. Prakasa Rao (*A.M.*) (*Journal*, vol. 46, no. 3, pt. CI 2, November 1965)

Railway Engineering Group

(1) Address by D. N. Chopra (*M.*), *Chairman*

(2) 'Locomotive Workshop of Northern Railway at Amritsar' by Iqbal Singh (*Non-member*) and G. S. Ahluwalia (*A.M.*) (*Journal*, vol. 45, no. 5, pt. CI 3, January 1965)

(3) 'Welded Rails in Rail Track' by H. N. Sil (*M.*) (*Journal*, vol. 45, no. 7, pt. CI 4, March 1965)

(4) 'Pile Foundations on the Railways' by Kali Charan (*M.*) (*Journal*, vol. 46, no. 3, pt. CI 2, November 1965)

(5) 'Studies on Railway Accidents—3 : Cost of Accidents' by T. C. Sarkar (*Non-member*) and C. P. S. Ayyar (*Non-member*) (*Journal*, vol. 46, no. 3, pt. CI 2, November 1965)

Mining and Metallurgy Division

(1) Address by Dr. G. P. Chatterjee (*M.*), *Chairman*

(2) 'Working with Bucket Wheel Excavators' by R. Bhadada (*A.M.*) (*Journal*, vol. 45, no. 7, pt. MM 2, March 1965)

(3) 'Geophysics and Engineering' by Dr. V. K. Gaur (*Non-member*) (*Journal*, vol. 45, no. 11, pt. MM 3, July 1965)

(4) 'Automation in Dolomite Brick Manufacture' by Ing. W. Schürmann (*Non-member*) (*Journal*, vol. 45, no. 11, pt. MM 3, July 1965)

(5) 'Present Status of Coal Mine Mechanization in Europe' by R. K. Singhal (*Non-member*) (*Journal*, vol. 45, no. 11, pt. MM 3, July 1965)

Petroleum Engineering Group

(1) Address by Dr. A. Lahiri (*M.*), *Chairman*

(Details to be announced at the meeting)

Electrical Engineering Division

1. Address by Prof. H. C. Guha (*M.*), *Chairman*
2. 'Application of Monte Carlo Games in the Analysis of A.C. Networks—1' by Dr. S. Das Gupta (*A.M.*) and A. K. Roy (*Non-member*) (*Journal*, vol. 45, no. 6, pt. EL 3, February 1965)
3. 'Calculation of Starting Torque for Single-Phase Induction Motor with Particularly Open Cage Rotor' by B. G. Desai (*Non-member*) (*Journal*, vol. 45, no. 6, pt. EL 3, February 1965)
4. 'Ionization in Insulating Materials' by Dr. L. M. Hore (*A.M.*) (*Journal*, vol. 45, no. 6, pt. EL 3, February 1965)
5. 'Transient Starting Currents in Three-Phase Induction Motor' by Amarjit Singh (*Non-member*) (*Journal*, vol. 45, no. 10, pt. EL 5, June 1965)
6. 'Transient Currents in Three-Phase Induction Motor on Reconnection with Supply Line' by Amarjit Singh (*Non-member*) (*Journal*, vol. 45, no. 12, pt. EL 6, August 1965)

7. 'Torque in an Electrical Machine—How It is Produced' by Dr. A. K. Das Gupta (*M.*) (*Journal*, vol. 45, no. 12, pt. EL 6, August 1965)
8. 'Study of Harmonics in Charging Current and Receiving End Voltage of an Open-Circuit 66 kV Line' by N. Krishna Murthy (*Non-member*) and Prof. D. J. Badkas (*A.M.*) (*Journal*, vol. 45, no. 12, pt. EL 6, August 1965)
9. 'Single-Phasing of Three-Phase Induction Motors' by T. V. Sreenivasan (*A.M.*) (*Journal*, vol. 46, no. 2, pt. EL 1, October 1965)
10. 'Self-Regulation of Alternators—a New Device' by S. C. Rao (*Non-member*) (*Journal*, vol. 46, no. 2, pt. EL 1, October 1965)
11. 'Fair Weather Corona Loss on Bundle-Conductor Lines' by V. N. Rikh (*A.M.*) (*Journal*, vol. 46, no. 2, pt. EL 1, October 1965)
12. 'Power Demand in Punjab Region and Measures to Meet It' by A. D. Kokane (*A.M.*) (*Journal*, vol. 46, no. 4, pt. EL 2, December 1965)
13. 'Transient Performance of a Saturated Synchronous Machine under Unbalanced Load—1 and 2' by P. K. Mukherjee (*Non-member*) (*Journal*, vol. 46, no. 4, pt. EL 2, December 1965)

Nuclear Engineering Group

The Chair of the Nuclear Engineering Group is vacant at present and there are no papers for discussion in this Group.

Marine Engineering and Shipbuilding Group

1. Address by Shri S. Basu (*M.*), *Chairman*

(*Details to be announced at the meeting*)

THIRD SESSION: WEDNESDAY, FEBRUARY 2, 1966: 9.00 a.m. to 12.00 noon

(common to all Divisions and Groups)

Paper Meetings in the Divisions and Groups may be continued, as desired by the Chairmen, in this Session.

FORTY-SIXTH ANNUAL CONVENTION
PATNA, JANUARY 29-FEBRUARY 5, 1966

ACCEPTANCE FORM FOR DELEGATES

Original—to be sent to :

The Honorary Secretary,
Bihar Centre, The Institution of Engineers (India),
Hardinge Road, Patna 1, Bihar.

This form together with the necessary remittances in respect of self and accompanying guests for Hotel Accommodation, Registration, General Transport, Local Visits, Outstation Tours (if participating), Service Fee for Return Reservation, and Bank Discount on outstation cheques, should positively reach the Bihar Centre **not later than December 31, 1965.** Forms received after that date or without advance remittances, as also provisional forms, will not be accepted, and no reservations will be handled in such cases. Requests for all these reservations will be dealt with and confirmed (if time permits) in the order in which the forms are received.

(Please fill in block letters)

Name ....

Grade and Membership No. ....

Your Local Centre ....

Address for communication ....

....

....

Arrival, accommodation and return travel

I, accompanied by ......lady/ladies,......gentleman/gentlemen and.... servant/s will arrive in Patna from............by............train/......air service on January. ...., 1966, at a.m./p.m. I/We desire/do not desire* to be met at Patna railway station/I.A.C. office* and require/do not require* transport to the hotel fixed for me/us.*

I/We desire/do not desire* to reserve accommodation during our stay at Patna for .... days from January ....to February...., 1966 (both days inclusive) in .... as a first choice/and.................... ....as a second choice.†

I/We desire/do not desire* travel reservation by.................... train/....................air service for return journey to................ on February......, 1966.

---

* Please retain your choice and strike off the other.

† Indicate your choice from the list of hotels given in the earlier pages.

Payments for Reservations

I enclose a cheque*/have sent a money order for Rs. ....to cover the following payments :

(i)	Hotel Accommodation for ....persons at Rs..... per person for....days from January....to February...., 1966 (both days inclusive)	Rs.
(ii)	Registration Fee for Self (Rs. 15.00 per member other than Students, and Rs. 10.00 per Student)	Rs.
(iii)	Registration Fee (Rs. 10.00 per Lady Guest) for.... Lady/Ladies	Rs.
(iv)	General Transport (Rs. 10.00 per person) for ....person/s	Rs.
(v)	Local Visits on February 2/3, 1966* (Rs. 5.00 person per visit) for....person/persons	Rs.
(vi)	Outstation Tour 1/Tour 2/Tour 3/Tour 4/Tour 5* (Rs. 115 per person per Tour for Tours 1 to 4 and Rs. 23 per person for Tour 5) for......... person/s	Rs.
(vii)	Special Tour to Rajgir (Rs. 23 per person) for.... person/s	Rs.
(viii)	Service Fee for Return Reservation (Rs. 5.00 per seat/berth) for......seat/s/berth/s	Rs
(ix)	Bank Discount on outstation cheques (Rs. 0.62P. per Rs. 100.00 or part thereof)	Rs.
	Total	Rs.

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* Cheques should be made in the name of The Institution of Engineers (India), Bihar Centre

Participation and Transport Requirements

Date	I/We* desire to attend	Indicate your transport requirement from the hotel and back*
Saturday, January 29, 1966	First/Second Session* of the Seminar	YES NO
	Business Session of the 46th Annual General Meeting and Talk on Bio-Engineering	YES NO
Sunday, January 30, 1966	Inauguration of the 46th Annual General Meeting	YES NO
	The Ninth Sir Mokshagundam Visvesvaraya Lecture	YES NO
	Inauguration and Third Session of the Seminar	YES NO
	Visit to Rajgir and Nalanda (for delegates not participating in Outstation Tours)	YES NO
Monday, January 31, 1966	Fourth and Final Session of the Seminar	YES NO
	Paper Meetings (First Session)/Seminar (continued)*	YES NO
	Paper Meetings (continued)/Seminar (continued)*	YES NO
	'At Home'	YES NO
	Students' Session	YES NO
	Variety Entertainment	YES NO
Tuesday, February 1, 1966	Paper Meetings (Second Session)	YES NO
	Paper Meetings (continued)	YES NO
	At Home	YES NO
	Variety Entertainment	YES NO
Wednesday, February 2, 1966	Paper Meetings (Third Session)	YES NO
	Seminar (continued)	YES NO
	Closing Session of the 46th Annual General Meeting	YES NO
	Local Visits (for delegates participating in Outstation Tours)	YES NO
Thursday, February 3, 1966	Local Visits (for delegates not participating in Outstation Tours)	YES NO

Outstation Tours

I/We desire to join Tour .... as a first choice.*
Tour .... as a second choice.*

Date.................... *Signature*..........................

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* Please retain your choice and strike off the other.

FORTY-SIXTH ANNUAL CONVENTION
PATNA, JANUARY 29-FEBRUARY 5, 1966

ACCEPTANCE FORM FOR DELEGATES

Duplicate—to be retained

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Hardinge Road, Patna 1, Bihar.

This form together with the necessary remittances in respect of self and accompanying guests or Hotel Accommodation, Registration, General Transport, Local Visits, Outstation Tours (if participating), Service Fee for Return Reservation, and Bank Discount on outstation cheques, should positively reach the Bihar Centre **not later than December 31, 1965.** Forms received after that date or without advance remittances, as also provisional forms, will not be accepted, and no reservations will be handled in such cases. Requests for all these reservations will be dealt with and confirmed (if time permits) in the order in which the forms are received.

(Please fill in block letters)

Name ....

Grade and Membership No. ....

Your Local Centre ....

Address for communication ....

....

....

Arrival, accommodation and return travel

I, accompanied by ......lady/ladies,. .....gentleman/gentlemen and.... servant/s will arrive in Patna from............by............train/......air service on January......, 1966, at a.m./p.m. I/We desire/do not desire* to be met at Patna railway station/I.A.C. office* and require/do not require* transport to the hotel fixed for me/us.*

I/We desire/do not desire* to reserve accommodation during our stay at Patna for .... days from January ....to February...., 1966 (both days inclusive) in .... as a first choice/and.................... ....as a second choice.†

I/We desire/do not desire* travel reservation by.................. train/....................air service for return journey to............... on February......, 1966.

---

* Please retain your choice and strike off the other.

† Indicate your choice from the list of hotels given in the earlier pages.

Payments for Reservations

I enclose a cheque*/have sent a money order for Rs. ....to cover the following payments :

(i)	Hotel Accommodation for ....persons at Rs..... per person for....days from January....to February...., 1966 (both days inclusive)	Rs.
(ii)	Registration Fee for Self (Rs. 15.00 per member other than Students, and Rs. 10.00 per Student)	Rs.
(iii)	Registration Fee (Rs. 10.00 per Lady Guest) for.... Lady/Ladies	Rs.
(iv)	General Transport (Rs. 10.00 per person) for ....person/s	Rs.
(v)	Local Visits on February 2/3, 1966* (Rs. 5.00 per person per visit) for....person/persons	Rs.
(vi)	Outstation Tour 1/Tour 2/Tour 3/Tour 4/Tour 5* (Rs. 115 per person per Tour for Tours 1 to 4 and Rs. 23 person for Tour 5) for........... person/s	Rs.
(vii)	Special Tour to Rajgir (Rs. 23 per person) for...... person/s	Rs.
(viii)	Service Fee for Return Reservation (Rs. 5.00 per seat/berth) for......seat/s/berth/s	Rs.
(ix)	Bank Discount on outstation cheques (Rs. 0.62P. per Rs. 100.00 or part thereof)	Rs.
	Total	Rs.

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* Cheques should be made in the name of The Institution of Engineers (India), Bihar Centre.

Participation and Transport Requirements

Date	I/We* desire to attend	Indicate your transport requirement from the hotel and back*	
Saturday, January 29, 1966	First/Second Session* of the Seminar	YES	NO
	Business Session of the 46th Annual General Meeting and Talk on Bio-Engineering	YES	NO
Sunday, January 30, 1966	Inauguration of the 46th Annual General Meeting	YES	NO
	The Ninth Sir Mokshagundam Visvesvaraya Lecture	YES	NO
	Inauguration and Third Session of the Seminar	YES	NO
	Visit to Rajgir and Nalanda (for delegates not participating in Outstation Tours)	YES	NO
Monday, January 31, 1966	Fourth and Final Session of the Seminar	YES	NO
	Paper Meetings (First Session)/Seminar (continued)*	YES	NO
	Paper Meetings (continued)/Seminar (continued)*	YES	NO
	At Home	YES	NO
	Students' Session	YES	NO
	Variety Entertainment	YES	NO
Tuesday, February 1, 1966	Paper Meetings (Second Session)	YES	NO
	Paper Meetings (continued)	YES	NO
	At Home	YES	NO
	Variety Entertainment	YES	NO
Wednesday, February 2, 1966	Paper Meetings (Third Session)	YES	NO
	Seminar (continued)	YES	NO
	Closing Session of the 46th Annual General Meeting	YES	NO
	Local Visits (for delegates participating in Outstation Tours)	YES	NO
Thursday, February 3, 1966	Local Visits (for delegates not participating in Outstation Tours)	YES	NO

Outstation Tours

I/We desire to join Tour .... as a first choice.*

Tour .... as a second choice.*

Date.................... *Signature*.........................

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* Please retain your choice and strike off the other

FORTY-SIXTH ANNUAL CONVENTION
PATNA, JANUARY 29-FEBRUARY 5, 1966

ACCEPTANCE FORM FOR LADIES

Original—to be sent to :

The Honorary Secretary,
Bihar Centre, The Institution of Engineers (India),
Hardinge Road, Patna 1, Bihar.

This form should be filled in by ladies desirous of attending the Annual Convention and participating in the Ladies' Programme and other social functions during the Convention. The form must be attached to and returned along with the Acceptance Form of the delegate whom they accompany.

(Please fill in block letters)

Name ....

Name of member with whom attending
the Convention ....

Address for communication..

....

....

Date	I desire to attend	Indicate your transport requirement from hotel and back*
Sunday, January 30, 1966	Inauguration of the 46th Annual General Meeting	YES NO
	The Ninth Sir Mokshagundam Visvesvaraya Lecture	YES NO
	Visit to Rajgir and Nalanda (for delegates not participating in Outstation Tours)	YES NO
Monday, January 31, 1966	'At Home'	YES NO
	Variety Entertainment	YES NO
Tuesday, February 1, 1966	'At Home'	YES NO
	Variety Entertainment	YES NO

* Please retain your choice and strike off the other.

Wednesday, February 2, 1966	Closing Session of the 46th Annual General Meeting	YES	NO
	Local Visits (for delegates participating in Outstation Tours)	YES	NO
Thursday, February 3, 1966	Local Visits (for delegates not participating in Outstation Tours)	YES	NO
	Ladies' Programme (as may be announced)	YES	NO

Outstation Tours

I desire to join Tour ....as a first choice.*
Tour ....as a second choice.*
(Indicate Tour no.)

Date.................... *Signature*..........................

FORTY-SIXTH ANNUAL CONVENTION
PATNA, JANUARY 29-FEBRUARY 5, 1966

ACCEPTANCE FORM FOR LADIES

Duplicate—to be retained

The Honorary Secretary,
Bihar Centre, The Institution of Engineers (India),
Hardinge Road, Patna 1, Bihar.

This form should be filled in by ladies desirous of attending the Annual Convention and participating in the Ladies' Programme and other social functions during the convention. The form must be attached to and returned along with the Acceptance Form of the delegate whom they accompany.

(Please fill in block letters)

Name ....

Name of member with whom attending

the Convention ....

Address for communication ....

....

....

Date	I desire to attend	Indicate your transport requirement from hotel and back*
Sunday, January 30, 1966	Inauguration of the 46th Annual General Meeting	YES NO
	The Ninth Sir Mokshagundam Visvesvaraya Lecture	YES NO
	Visit to Rajgir and Nalanda (for delegates not participating in Outstation Tours)	YES NO
Monday, January 31, 1966	'At Home'	YES NO
	Variety Entertainment	YES NO
Tuesday, February 1, 1966	'At Home'	YES NO
	Variety Entertainment	YES NO

* **Please retain your choice and strike off the other.**

Wednesday, February 2, 1966	Closing Session of the 46th Annual General Meeting	YES	NO
	Local Visits (for delegates participating in Outstation Tours)	YES	NO
Thursday, February 3, 1966	Local Visits (for delegates not participating in Outstation Tours)	YES	NO
	Ladies' Programme (as may be announced)	YES	NO

Outstation Tours

I desire to join Tour ....as a first choice.*
Tour ....as a second choice.*
(Indicate Tour no.)

Date.....................

Signature.........................

Please tear off here and send the Form early to the Secretary at the Headquarters Office in Calcutta to ensure its quick return to you.

THE INSTITUTION OF ENGINEERS (INDIA)

8 Gokhale Road, Calcutta-20

Subject: Rail concession to delegates attending the 46th Annual General Meeting at Patna in January-February 1966.

Railway Board Ref.: TC-II/2135/65 dated New Delhi, October 26, 1965

Certificate Form for Rail Concession

It is certified that Shri/Shrimati is a person travelling from..............................to..............to attend the 46th Annual General Meeting to be held at Patna from January 29 to February 5, 1966, and is entitled to the concession of return tickets in any class available for one month as indicated below:

Class	On payment of*
First class return tickets	Single first class fares
Second class return tickets	Single second class mail fares
Third class return tickets	Single third class mail fares

(i) He/She is a servant of the Central/State Government/local body or a Statutory authority.

(ii) He/She is not a servant of the Central/State Government/local body or a Statutory authority.

(iii) His/Her travelling expenses will not be borne by the Central/State Government/local body or a Statutory authority.

Place..............
....
Secretary
Date..............

OFFICE STAMP OF THE INSTITUTION

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† I hereby certify that I am an employee of the Central/State Government/local body or a Statutory authority and that I shall not claim mileage allowance from the Central/State Government/local body or Statutory authority for the journey performed on the concessional return ticket.

Date.................. Signature................................
Place.................. Designation............................
Office address..

† *Note*: 1. This certificate must invariably be filled in by employees of Central/State Government/local body or a Statutory authority.

2. Government servants, etc. whose travelling expenses are borne by the Central/State Government or a local body or a Statutory authority either wholly or even partly are not entitled to this concession. Any breach of this rule by the Government servant will render him liable to disciplinary action.

Keep this with you till after the Annual General Meeting, and then return it to the Headquarters.

I availed of the rail concession given by the Railway Board for members of the Institution attending its Annual General Meetings, and travelled on this concession from..............................to Patna and back from Patna to..............................

Name of delegate..
Signature..
Date

ANNUAL REPORT OF THE COUNCIL FOR 1964-65*

The Council present to members the Annual Report for the year ended August 31, 1965.

1. Membership

1.1. *Members on the Roll*

The Roll of the Institution on August 31, 1965, stood at 54,502 with members and attached persons and bodies under different grades as below:

Honorary Members	Honorary Life Members	Members	Associate Members	Companions	Graduates	Students	Affiliates	Subscribers	Total
11	5	1,894	10,037	6	1,836	40,643	10	60	54,502

1.2. *Applications*

The position of applications for membership received and considered during the year under report was as follows:

Number of applications brought forward from the year 1963-64 ..	1,722
Fresh applications received during the year ..	13,058
	14,780
Balance at the end of the year awaiting disposal ..	2,381

1.3. *Year-Book* 1963-64.

The fourth edition of the Year-Book of the Institution, corrected to August 31, 1964, was published in February 1965.

1.4. *Obituary*

The Council regret to record the deaths of the following members during the year.

Members

Albert De Souza, Govind Trimbak Gokhale, Krishna Chandra Govel, Indra Nath Hazarika, Rangrao Ganeshrao Islur, Muliyil Karuven, Carnapathi Vencata Krishnaswami Chetty, Lt.-Col. George Lobo, Bhagwandas Atmaram Mehta, Sarat Chandra Mitra, Subramonia Ramchandra, Abhoy Pado Roy, Har Govind Trivedi, G. Venkataraman.

Associate Members

Maj. Inderjit Abbi, Naresh Chandra Bhargava Narayandas Choudhury, Nikhil Chandra Das Gupta, Chunilal Becharlal Doshi, P. I. Narayana Iyer, Joseph Aloysius Silverius Menezes, Vaman Mahadeo Ogale, K. Papa Rao, Gurdas Ram Sainbhi, Yogendra Devraj Shukla, Maj. Plavelil Abraham Thomas, Maj. Harbans Lal Vaid, Bhanduvula Venkatachalam.

Graduate

Kumara Narasimhan Ravindra.

Students

Soshil Chandra Bhatia, Anil Kumar Gupta, Fg.-Off. Kambala Kannan, T. G. Krishna Rao.

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* The Annual Reports appears here in abridged form.

2. Finance and Accounts

2.1. The Statement of Accounts and the Balance Sheet duly audited by the Institution's Auditors for the year ended August 31, 1965, is given in Appendix I of the Annual Report (*not included here*).

2.2. The donations received during the year under report are given in the full Annual Report.

2.3. *Public Charitable Trust for the Advancement of Engineering Education*

The following members were the Trustees of the Trust for the year: Prof. N. S. Govinda Rao, President, Dr. T. Sen, Maj.-Gen. Harkirat Singh, Dr. K. L. Rao, and D. P. R. Cassad, Past-Presidents.

3. The Council

During the year under report, the following Council meetings were held:

1. Ahmedabad (C.M. 436, September 13, 1964), 2. New Delhi (C.M. 437, December 13, 1964), 3. Lucknow (C.M. 437 *adjourned*, February 20, 1965), 4. Lucknow (C.M. 438 *special*, February 23, 1965), 5. Lucknow (C.M. 439, February 23, 1965), 6. Bhubaneswar (C.M. 440 special May 2, 1965), 7. Bhubaneswar (C.M. 441, May 2, 1965), and 8. Bangalore (C.M. 442, August 28, 1965).

4. Standing Committees of the Council

4.1. The Finance Committee of the Council consisted of the following members.

The President, Prof. M. V. Deshpande, M. Ganapati, B. P. Kapadia, K. N. Misra, Maj.-Gen. S. P. Vohra.

4.2. The Examinations Committee of the Council consisted of the following members:

(1) *From September* 1, 1964 to *February* 19, 1965.

The President, K. C. Banerjee, Dildar Husain, V. G. Garde, Prof. N. S. Govinda Rao, and Brig. P. R. Kumar.

(2) *From February* 20, 1965.

The President, Prof. S. J. Arceivala, Dr. A. K. Chatterjee, Dr. G. P. Chatterjee, Prof. P. W. Dharap, Dr. V. M. Dokras, Prof. A. Lakshmanaswamy, and Dr. S. P. Luthra.

4.3. *Engineering Research Committee*

The Committee consisted of the following members.

From September 1, 1964 *to February* 22, 1965.

Prof. M. V. Deshpande (*Convenor*), Dr. A. K. Chatterjee, Dr. G. P. Chatterjee, Dr. V. M. Dokras, Prof. N. S. Govinda Rao, T. R. Gupta, Prof. R. S. Mehta, Dinesh Mohan, Dr. Jai Krishna, R. N. Joshi, A. R. Narayana Rao, Prof. S. Rajaraman, Dr. Swami Sharan, Dr. H. C. Visvesvaraya and B. R. Subramanyam (*Secretary*).

4.4. *Engineering Education Committee*

The Committee consisted of the following members:

From September 1, 1964 *to February* 22, 1965.

Prof. N. S. Govinda Rao (*Convenor*), Dr. A. K. Chatterjee, Dr. G. P. Chatterjee, Prof. M. V. Deshpande, Dr. V. M. Dokras, T. R. Gupta, Prof. R. S. Mehta, G. K. Agarwal, G. K. Chandiramani, G. C. Goswami, R. N. Joshi, Prof. S. Panchanathan,

T. S. Randhawa, K. F. Antia, Brig. S. K. Bose, J. Datt, and B. R. Subramanyam (*Secretary*).

4.5. *Engineering Education and Research Committee*

On February 23, 1965, the Engineering Education Committee and the Engineering Research Committee was combined together and renamed 'Engineering Education and Research Committee'. The Committee consisted of the following members from May 22, 1965 :

Prof. M. V. Deshpande (Convenor), Brig. S. K. Bose, G. K. Chandiramani, Prof. P. S. Kalwachwala, Prof. H. N. Ramachandra Rao, Dr. H. C. Visvesvaraya, Dr. G. P. Chatterjee, Prof. H. C. Guha, T. R. Gupta, S. K. Majumder, K. K. Nambiar, Brig. M. K. Rao, J. G. Bodhe, G. S. Desai, R. N. Joshi, Prof. D. G. Tamaskar, and B. R. Subramanyam (*Secretary*).

4.6. *Flood Control Committee*

The Committee consisted of the following members :

Dildar Husain (*Convenor*), P. R. Ahuja, Prof. N. S. Govinda Rao, C. L. Handa, D. V. Joglekar, B. P. Kapadia, S. Varadaraja Sarma, and Dr. H. L. Uppal.

4.7. *Power Supply Management and Organization Committee*

The Committee consisted of the following members :

P. K. Ghosh (*Convenor*), Prof. M. V. Deshpande N. K. De Sirkar, G. C. Goswami, V. Y. Kamat, H. S. Kulkarni, B. N. Ojha, K. S. Ramu, Prof. A. Srinivasan and S. Mukhopadhyay (*Secretary*).

5. Revision of Regulations of the Council

A Special General Meetings of the Corporate Members was held in Bombay on 24th October, 1964, to consider revisions to Regulations 7(a), (d), (f) and (g) and 15(a), (d), (f) and (g) which were proposed by the Council, and which were recommended by the Council to the Corporate Members at their 436th Meeting held in Ahmedabad on 13th September, 1964. The revisions were passed.

6. The *Journal* and the *Bulletin*

6.1. *The year's publications*

The *Journal* was divided into seven Parts corresponding to the Divisions of the Institution. These were: Civil Engineering Division; Mechanical Engineering Division; Electrical Engineering Division; Electronics and Telecommunication Engineering Division; Chemical Engineering Division; Mining and Metallurgy Division; and Public Health Engineering Division. The *Journal* Parts were regularly issued under this scheme during the year.

The *Bulletin* was published each months as heretofore.

6.2. *Technical Papers*

The number of technical papers and articles published under the various Divisions and Groups in the *Journal* during the year were: Civil Engineering Division 66, Mechanical Engineering Division 30, Electrical Engineering Division 29, Electronics and Telecommunication Engineering Division 15, Chemical Engineering Division 5, Mining and Metallurgy Division 6, Public Health Engineering Division 9, Concrete Construction Group 11, Domes, Plates and Shells Group 2, Railway Engineering Group

6, Roads and Road Transportation Group 1, Industrial Engineering Group 3, Marine Engineering and Shipbuilding Group *nil*, Nuclear Engineering Group *nil*, and in the *Bulletin*, 9, articles were published in the same period, making a total of 169. Besides these, 2 articles on Contemporary World Projects and 45 discussions on papers were also published.

The number of papers recieved during the year was 180. Out of these 72 were approved for publication, and 35 were awaiting the recommendations of the Divisional Chairmen.

6.3. *Hindi Section*

The Hindi Section continued to be guided by Shri Brijmohan Lal, Adviser. Under the new scheme of publications, its Journal was issued in December 1964, April and August 1965. The total number of papers published was ten out of which six were on Civil Engineering, three on Mechanical Engineerng and one on General Engineering. The total number of pages was 124.

6.4. *Museum of Indigenous Technical Literature*

Seven books have been added to the Museum during the year at a cost of Rs. 456. The Museum is under the charge of Nagpur Centre and works under the guidance of Shri Brijmohan Lal, Adviser, Hindi Section.

7. **Examinations**

7.1. *Results of examinations held in November 1964 and May 1965*

The summary of results of the Institution examinations held in November 1964 and May 1965 were as follows.

November 1964 Examinations

Examination	Number of candidates appeared	Number of candidates appeared in all subjects (in one or more sittings)	Number of candidates passed	Percentage of pass
Studentship ..	649	462	68	14.7
Section A (*Old Scheme*) ..	3015	1744	605	34.5
Section A (*New Scheme*) ..	5936	940	197	20.8
Section B (*Old Scheme*) ..	728	625	315	50.0
Section B (*New Scheme*) ..	1574	489	103	20.9

May 1965 Examinations

Examination	Number of candidates appeared	Number of candidates appeared in all subjects (in one or more sittings)	Number of candidates passed	Percentage of pass
Studentship ..	777	573	120	20.7
Section A (*Old Scheme*) ..	2432	1635	662	40.5
Section A (*New Scheme*) ..	6947	1299	303	23.2
Section B (*Old Scheme*) ..	461	408	180	43.8
Section B (*New Scheme*) ..	2244	748	217	28.5

8. Recognition of Exempting Qualifications

(a) The following qualifications were recognized as exempting from the Studentship Examination of the Institution :

(1) Diploma in (i) Civil, (ii) Mechanical, and (iii) Electrical Engineering of the State Board of Technical Education, Jammu and Kashmir.

(2) Diploma in Chemical Engineering of the University of Kerala.

(3) Apprentice Mechanics Course of the Kanchrapara Technical School, Kanchrapara.

(4) 4-year Sandwich Course in Mechanical Engineering of the State Board of Technical Education and Training, Andhra Pradesh.

(5) Diploma in Mining Engineering of the State Council of Technical Education and Training, Orissa.

(6) Sandwich Course in (i) Mechanical, and (ii) Structural Fabrication Engineering of the State Council for Engineering and Technical Education, West Bengal.

(7) Apprentice Mechanics Final Examination of the Indian Railways School of Mechanical & Electrical Engineering, Jamalpur.

(8) 4-year Sandwich Course in Mechanical Engineering of the State Board of Technical Education, Madras.

(9) Junior Technical Course of the College of Engineering and Technology, Jadavpur, from the session 1941-42.

(b) The following qualifications were recognized as exempting from Section A only of the Associate Membership Examination :

(1) M.Sc. degree in Engineering and Applied Geology of the College of Engineering and Technology, Jadavpur.

(2) M.Sc. degree in Engineering and Applied Geology of the Jadavpur University.

(c) The following qualifications were recognized as exempting from Section A and B of the Associate Membership Examination :

(1) B.E. degree in (i) Electrical Communication, (ii) Electrical Technology, and (iii) Metallurgy of the Indian Institute of Science, Bangalore.

(2) B.E. degree in (i) Civil, (ii) Electrical, (iii) Mechanical and (iv) Telecommunication Engineering of the Birla Institute of Technology & Science, Pilani, Rajasthan.

(3) M.Sc. (Tech.) degree in Electronics of the Birla Institute of Technology & Science, Pilani, Rajasthan.

(4) B. Tech. degree in (i) Chemical Engineering, and (ii) Mining Engineering of the Indian Institute of Technology, Kharagpur.

(5) B. Tech. degree in (i) Civil, (ii) Mechanical, (iii) Electrical, (iv) Chemical, and (v) Metallurgical Engineering of the Indian Institute of Technology, Bombay.

(6) All India Diploma (National Diploma) in Chemical Engineering and Chemical Technology of the All India Council for Technical Education.

(7) B.Sc. (Eng.) degree of the Utkal University in the following branches of engineering conducted at the colleges mentioned below :

I.	Civil Engineering	University College of Engineering, Burla
	Electrical Engineering	
	Mechanical Engineering	
II.	Chemical Engineering	Regional Engineering College, Rourkela
	Civil Engineering	
	Electrical Engineering	
	Mechanical Engineering	
	Metallurgical Engineering	

(8) B.Sc. (Eng.) degree of the Ranchi University in the following branches of Engineering, conducted at the colleges mentioned below :

I. Chemical Engineering Civil Engineering Electrical Engineering Mechanical Engineering Metallurgical Engineering Production Engineering Telecommunication Engineering	Bihar Institute of Technology, Sindri
II. Civil Engineering Electrical Engineering Mechanical Engineering Telecommunication Engineering	Birla Institute of Technology, Ranchi

(9) B.E. degree in (i) Civil, (ii) Mechanical, (iii) Electrical Engineering of the Shivaji University, Kolhapur, conducted at the Walchand College of Engineering, Sangli, and the College of Engineering, Karad, which were originally affiliated to the Poona University.

(10) D.I.I.Sc. in Chemical Engineering of the Indian Institute of Science, Bangalore.

(11) B.Sc. (Eng.) degree in (i) Civil, (ii) Mechanical, and (iii) Electrical Engineering of the Vikram University, conducted at the Maulana Azad College of Technology, Bhopal.

(12) B.Sc. (Eng.) degree in (i) Electrical, and (ii) Mechanical Engineering of the Patna University, conducted at the Bihar College of Engineering, Patna.

9. Annual General Meeting

The 45th Annual General Meeting was held in Lucknow between February 20-23, 1965.

A full account of the 45th Annual Convention was published on pages 4-71, of the Bulletin, vol. 14, no. 8, April 1965.

10. Representation on other bodies

The names of the representatives of the Institution on other bodies are given in Appendix II of the Annual Report (*not included here*).

11. Paper Meetings at Local Centres, Visits and Excursions

Details are given in Appendix III of the full Annual Report.

12. The Council wish to thank the many honorary workers for their very valuable service rendered during the year and to record that they are deeply conscious of their contribution. In particular, the Standing Committees of the Council, the Committees of the Local Centres, and Shri Brijmohan Lal, Adviser, Hindi Section, deserve mention. The Council also acknowledge with appreciation the great volume of work conducted by the staff of the Headquarters, Local Centre and Sub-Centre Offices.

ADDRESSES OF CHAIRMEN AT THE ANNUAL GENERAL MEETINGS OF THE LOCAL CENTRES

Nagpur Centre

Chairman's address by Shri R. M. Tarkunde, B.E., M.I.E., at the Annual General Meeting of the Centre on January 17, 1965

The Chairman welcomed the Chief Guest, Dr. K. L. Rao, Minister for Irrigation and Power, Government of India, and other invitees, and thanked the Committee of the Centre for electing him Chairman for the year 1964-65.

Delivering his address, Shri R. M. Tarkunde said, 'Since 1935, I have been engaged in contracting organizations doing civil engineering constructions. My address, therefore, concerns the progress and problems of the building industry.

There was a great business slump in the world between 1930 and 1940. Jobs were difficult to find. There was heavy retrenchment from government departments. Unemployment and economic depression drove even first class engineers into desperation.

The building industry had not developed much in those days. There was scarcity of work generally and constructions as came up were far too slow compared with the tempo of work of the present day. But slow speed had other advantages. Engineers had more time to supervise. Workmanship was of a higher quality than it is today.

In course of time, the changing social, economic and political conditions in the country had their impact on the building industry. The requirements and expectations changed. Scientific advancement brought about improvement and accuracy in designing. The high speed of development necessitated greater mechanization in the building industry.

India was then under the fetters of British sovereignty. The handful of British administrators in India found that centralization of power was necessary for governing this vast sub-continent. It was to support this form of government that rules and procedures were framed. Many of these rules and procedures still persist as the British legacy in our administration.

There followed a world depression caused by over-production of consumer goods. There was a lot of commodities in the market but people did not have the resources to buy. The suffering due to extremeties such as low wages, unemployment and hunger were appalling.

With Hitler's rising ambitions, the Second the war broke out in 1939.

The bureaucracy in India took up the challenge of the war in their own way. The British administration in India fully rose to the occasion with alertness. The stringency of peace time rules and procedures was at once moderated to suit the changed situation.

A considerable part of the war preparations concerned the building industry. Construction of hutments for accommodation of troops, training centres for cadets, temporary and permanent air strips, ammunition factories and cantonments, bastions of strategic importance, etc. sprang up all over the country with terrible speed. The period was one of hectic activity for engineers. They were fortunate to have the taste of a major emergency and experience in emergency works. The building industry received a great fillip. The work load executed by engineers and contractors was stupendous. The war came to an end at last in 1945.

Another outcome of the war was the dissolution of the British empire in Asia. India achieved freedom in 1947, and under the leadership of Jawaharlal Nehru, the Congress Government was formed on the basis of parliamentary democracy.

Several construction works were kept pending during war time, giving preference to war works. Such works were started after the war. There was, however, some lull in the building industry.

In due course, the Planning Commission formulated the principles and aims of social and economic development of the country. Considerable stress was laid on the industrialization of the country and the production of food. An expenditure of Rs. 2,500 crores was envisaged in the First Plan. Engineers and builders were once again geared to a tempo of work faster than ever before.

Large scale projects were undertaken for the manufacture of steel, cement and fertilizers. The necessity to expand the production of electric power was recognized and a number of power houses, both hydro-electric and thermal, were undertaken. Large irrigation projects were planned and their construction taken in hand. Extensive programmes came up for roads and bridges, factories, buildings for academic institutions and other peaceful purposes. Side by side, the private sector kept pace with a large number of small and big industries.

The Second Plan target was increased to Rs. 5,000 crores, the current, *i.e.*, the Third Plan, was drawn up for Rs. 10,000 crores, and the Fourth Plan will exceed Rs. 20,000 crores.

A major portion of this expenditure concerns construction works of all types and the provision of indigeneous or imported machinery. All this development is largely the responsibility, of engineers. In order to measure up to this responsibility, they have to increase their capacity at the same rate as the increase in the plan expenditure.

This is an uphill task. Every work that is planned seems to have a stiffer limit for completion than the one before. Engineers are certainly kept up on their toes with the urgency and rush of these jobs.

I had occasion to discuss the question of continuing urgency of works with a Russian engineer. He told me with a quiet smile that he is yet to come across any construction in Russia which is not urgent.

With the extent of developments necessary for the country, our Five Year Plans will always be a permanent emergency for engineers and builders.

The recent incursion of China into our borders and the belligerant declarations of the neighbours, have only added to the seriousness of the situation. We have been required to take up a great number of defence works. It is hoped that our efforts for peaceful development will go on unhindered.

The building industry has developed considerably since the 1930's. Designs of irrigation works and civil engineering works for factories are being done in the country. We are also designing bridges and other prestressed concrete structures. We are using new varieties of machinery in building construction and many of the machinery and equipment are being manufactured in India. However, much requires to be done for the building industry to prepare it to fulfil our targets and aspirations.

I now wish to call attention to the problems that are restricting the growth of the building construction industry in our country.

There is a tendency amongst administrators and politicians to belittle the work done by engineers. It seems to me that this is done out of ignorance or lack of forethought. The cream out of our intelligent students is seeking admission to engineering colleges; and it is only the best amongst them that succeed in getting admission. Engineers are still in short supply. Contractors find it difficult to get sufficient personnel for their works. There is a paucity of skilled workers like masons, carpenters, fitters, mechanics, drivers, etc. There are no institutions to train them in their trades. There is no system for awarding trade certificates, with the result that the workers who report for work cannot be trusted for adequate quality or quantity of turnover. There is an acute shortage of accountants, typists and storekeepers of quality.

All our large project works are generally away from big towns. The engineers and workers are provided with temporary quarters on the worksite. There is a deplorable tendency among young men to stay in cities and thus avoid hard life on project works.

There are a number of reliable designers and consulting engineers for civil engineering works. Our country however lacks the designers of machinery and equipment. The need for them is being acutely felt in construction and other industries.

The availability of local materials or the nature of the foundations to be tackled are sometimes not properly studied. Designs based on inadequate data result in wastage and delay. Foundation geologists are not being consulted on important engineering works. This is essential in the interest of a safe design and economy.

Construction works under the plan projects are being managed by Government engineers. They are concerned with the making of plans, designing of structures, drawing of specifications and contract documents and supervising the works. All this is very technical. Even so, such a technical department is saddled with a non-technical administration, which is resulting in a lot of misunderstanding and delay.

The accounts department and the accounting rules and audit objections are a continuous headache to government engineers. A major part of the accounting rules were framed at the end of the last century. These rules and regulations require to be revised to suit the current times. In the majority of cases, it takes longer time to pay the final bill of a contractor than the time taken by the contractor to complete his work. The accountants should be helpful to engineers rather than be a hindrance.

It is found that new engineers in government service are not properly initiated in departmental procedure to undertake their responsibilities. There should be training centres to fully acquaint them with the rules and procedures. Considerable delays occur due to nonconformity with the rules.

For the success of our Five Year Plans, there must be full cooperation between the government, engineers and the contractors. The engineers must be trusted and should enjoy complete confidence. They should be protected against public calumnies and should not be made scapegoats. They should not be exposed to the odium of a public enquiry unless a departmental and technical enquiry justifies such a course. Generally, a government officer is judged by his faults. No recognition or credit is given for the work done by him. He therefore feels that the less he works the less fault he commits; then why work? To see that he steps out of this attitude, he needs to be enlivened by some recognition of his good work. The government is certainly not lacking in able and efficient personnel, only they are not enthused enough to give their best.

I cannot but make a reference to the problem of corruption. I am of the opinion that this question is exaggerated out of all proportions. It is undoubtedly true that corruption should be removed as an evil. But there are other evils which are equally repugnant to national well being. One such evil s the apathy and lack of initiative and enthusiasm among government employees. This evil is a direct result of the obsession about corruption. It has started a chain of suspicion to the extent of suffocating the healthy atmosphere. On the other hand, the other evil nullifies any attempt to tackle the urgent problems of the day such as food, agriculture and other development works.

I have spoken at some length about government officers and their working. It is not my intention to blame the Government or the administrators. I have described the situation purely in a constructive spirit. There is the genuine desire in the minds of most people to work for the country. I am optimistic about the future of our country and our engineers will acquit themselves with credit.'

Summaries of Papers Published in the Journal, vol. 46, no. 3, pts. CI 2, ME 2 and MM 1, November 1965

CIVIL ENGINEERING DIVISION

The Seven Depths in Prismatic Channels

Prof. R. M. Advani

Member

A brief analysis of the computation of seven depths in prismatic channels is presented in this paper. These depths are: the uniform or normal depth, the critical depth, the end depth, the two alternate depths, and the two sequent or conjugate depths. As far as possible, the various equations have been expressed in the non-dimensional form so as to make them universal in application.

Rapid Analysis of Thermal Stress in Intake Tower of a Hydro-Electric Project

B. Pant
Associate Member

and

P. T. Badhe
Non-member

The R.C.C. intake towers in a hydro-electric project support the trash racks and operate the gates at the intake end of the headrace tunnel or conduit. These structures remain partly under water and partly exposed to atmosphere; and hence, considerable thermal stress develops in them at certain periods of the year, particularly in the tropical regions. An estimate of the magnitude of thermal stress, which is necessary for design purposes, can be obtained by the analysis of a space frame involving the solution of a large number of simultaneous equations. This procedure is tedious and time consuming. This paper describes a rapid method of calculation of the thermal stress based on the theory of beams on elastic foundations and illustrates the same by calculating the thermal stress in the 176 ft. high intake tower of Koyna hydro-electric project. The results are verified by model tests and the general applicability and limitations of the method discussed.

Evaluation of *N*-Value from the Second Foot of Penetration of a Spoon Sampler

D. P. Sen Gupta
Graduate

and

V. S. Aggarwal
Student

In the standard penetration test, the relationship between the number of rammer blows and the progressive depth of penetration of the spoon sampler shows a point of inflexion at about 12 in. depth. This sudden change in soil resistance indicates the presence of a disturbed layer of soil at the base of the borehole up to about 12 in. depth. This paper, therefore, suggests that the *N*-value of the soil should be determined from the second foot of penetration of the spoon sampler.

PRESTRESSED CONCRETE GROUP

Effects of Transversals in T-Beams and Slab Bridges

Brajendra Kumar
Non-member

This paper studies the optimization of lateral load distribution in R.C.C. T-beams and slab bridges. It shows that amongst the various factors, the number and size of transversals play the most important role, and a centrally located transversal is the most effective for obtaining lateral load distribution. From an analysis of the calculated results, it concludes that there is only one value of transverse stiffness for a bridge for which the ratio between the assumed values of flexural rigidity of the longitudinals coincide with the fraction of the design load carried by them.

Large Deflections of Cantilevers by Relaxation Method

Dr. P. Desayi
Associate Member

The ordinary bending theory is not applicable for the analysis of slender bars under flexure because the deflections are very large. An exact solution of the nonlinear differential equation in the case of a bar having a fixed cross-section is possible and involves the use of elliptic integrals. For the bars having a varying cross-section or an initial curvature, an exact solution may not be possible; and in such cases, some numerical method will have to be adopted. This paper outlines a numerical procedure, based on relaxation principle, for the determination of large deflections of a cantilever having fixed or varying cross-section due to an end-concentrated load. The problem of a bar having fixed cross-section is worked out to illustrate the procedure and the results are compared with those obtained by the exact method.

Linear Graph Theory Applied to Structures—1 : Continuous Beams

P. S. Satsangi
Non-member

and

V. K. Garg
Non-member

This paper attempts to encompass the field of structures in the ever widening fold of the linear graph theory. It presents an application of the linear graph theory for the solution of the problem of a continuous beam on the basis of abstract linear graphs and matrices.

SHELL STRUCTURES GROUP

Deflection of Funicular Shell Square in Plan by Strain Energy Method

P. Dayaratnam
Associate Member

This paper presents the method of calculation of the deflection of a funicular shell, square in plan, by energy method. The deflection equation is obtained by minimizing the total potential energy of a shallow shell and it is compared with the deflection equation of a square plate. The deflection of the shell is found to be several times less than the deflection of a plate having similar dimensions. A small cement-mortar model is tested for deflection and the test results are compared with the calculated values.

Computer Analysis of Folded Plates by the Method of Transfer Matrices

M. Ramaiah
Associate Member

This paper presents a modification of Holand's method for the analysis of folded plates and extends it to analyze the northlight folded plate structures. It also presents a programme for analyzing a folded plate structure on an I.B.M. 1620 digital computer using the method.

RAILWAY ENGINEERING GROUP

Pile Foundations on Indian Railways

Kali Charan
Member

This paper describes the salient features of several pile foundations done by the Indian Railways and discusses in brief the preliminary investigations carried out, including the driving of test piles, placement of test loads, and determination of the ultimate resistance, allowable load, factor of safety, etc.

Studies on Railway Accidents—3 : Cost of Accident

T. C. Sarkar
Non-member

and

C. P. S. Ayyar
Non-member

This paper brings out that the financial loss due to a railway accident consists of direct and indirect cost. It analyzes the various elements comprising the direct and indirect cost and describes a method for calculating the cost of a railway accident.

From an analysis of the data published by the Indian Railways, it concludes that there is no definite mathematical relationship between the direct cost and the indirect cost of a railway accident.

ROADS AND ROAD TRANSPORTATION GROUP

Urban Transportation

P. G. Patankar
Associate Member

The problem of traffic congestion in cities is a global one and it exists in our cities too. The railways gave the nation mobility in the early days. Then came the automobile age and many persons became independent of the public transportation system by owning individual cars. However, the stupendous population concentration and large increase in automobiles are creating a crisis. If the problem of traffic congestion in cities is not solved early, it will raise the question whether a nation born in farms is destined to die in cities. This paper describes the various systems of mass transportation and gives a comparative economic survey of them. From a comparison of the overhead rapid transit system with the underground railways, it concludes that the provision of the latter is the only answer to the growing problem of rapid mass transportation.

Drawbacks of Bituminous Mix Design Methods

M. V. Prakasa Rao
Associate Member

This paper describes the requirements for satisfactory performance of a bituminous mix and brings out the factors affecting its performance. The drawbacks of the frequently adopted test of a bituminous mix and the triaxial test, which claims certain advantages over the former, are also discussed. Finally, the method of correlation of these test results with the field performance data of a bituminous mix, which is an important factor in determining the suitability of the laboratory tested mix, is described.

Planning of Highway System in Assam

G. C. Sharma
Member

This paper stresses the need for highway planning in general and describes the evolution of various patterns of highway system such as grid and star pattern, modified grid-star system, web and lattice pattern, crystal pattern, etc. in India. The deficiency of the existing highways in Assam is mentioned and the classification of highway system for future planning indicated in the paper. The hexagonal grid system of highway is suggested for Assam which satisfies most criteria specified in the Twenty Years Road Development Plan for India (1961-81).

MECHANICAL ENGINEERING DIVISION

Reaction Kinetics in Diesel Combustion

Maj. A. S. Bhullar
Associate Member

This paper stresses the importance of reaction kinetics theory for improving the efficiency of combustion of Diesel fuel in compression-ignition engines, rather than the atomization and penetration of the fuel spray. It analyzes the combustion process of each particle of the injected fuel and describes the M-combustion system, in which the reaction kinetics theory has been utilized to obtain a gas phase molecular mixture by allowing the fuel to evaporate in small dozes from the combustion chamber. The M-combustion system not only eliminates the Diesel knock and smoke but provides a multi-fuel engine which can burn a wide range of fuels, from petrol to crude oil.

Critical Speed of a Thin Rotating Disc with a Rigid Inclusion Welded at the Centre

K. Chakrabarti
Non-member

Many research workers have worked on the stress-strain characteristics of a thin rotating disc, of both solid and hollow types. Modern workers have also worked on the stress-strain behaviour of both solid and hollow elasto-plastic and plastic discs. They have found the critical speed for which a particular disc undergoes incipient yielding. This paper attempts to show the effect on the critical speed of a thin rotating disc due to a rigid circular inclusion welded at its centre and concludes that for a certain range of the inclusion diameter, there is no critical speed of the disc.

Supercharging of I.C. Engines for Power Loss Compensation at High Altitudes

K. P. Singh
Non-member

This paper presents a theoretical method for determining the capacity and design parameters of the compressor and turbine of an exhaust gas driven turbo-charger for the compensation of pressure loss at high altitudes, both for spark-ignition and compression-ignition engines. The relative merits of the various types of supercharger for this purpose are discussed and a relationship for assesing the performance of a supercharged engine is described.

Mechanics of Chip Breakers

T. L. Subramanian
Non-member
and
Dr. A. Bhattacharyya
Associate Member

Chip control in high speed machining presents a difficult problem, which can be tackled by a study on the chip flow mechanism to assess the conditions of chip failure. This paper develops an equation to correlate the instantaneous radius of curvature of the moving chip, considered as an elasto-plastic beam, with the chip thickness. From an analysis of the experimental data, it derives the equations for the upper and lower boundaries of the effective chip breaking zone.

Manufacture of Diesel Locomotives in India

V. A. Patel
Associate Member

This paper studies the different types of locomotives used in railway systems and brings out the superiority of a Diesel hydraulic locomotive over a steam locomotive. It stresses the need for manufacture of Diesel hydraulic locomotives in India and discusses the details involved in the setting up of such a manufacturing plant, *viz.*, selection of site, provision of other facilities, capital requirement, production programme, personnel training, etc.

MINING AND METALLURGY DIVISION

Occurrence and Prevention of Disasters in Mines

G. S. Marwaha
Member

This paper presents a brief comparative study on the accidents which take place in the various industries and stresses that the mining operations involve the maximum danger not only in India but the world over. It analyzes the causes which lead to mine disasters and from an analysis of the various data concludes that in spite of its inherent hazards, the annual death due to accidents in mining industry in India, employing about 800,000 workmen, is about the same as that due to the traffic accidents in any large city of the country. It also describes the preventive measures adopted to reduce mine accidents and indicates that the safety effort in mines are to be pursued continuously with an intense vigil.

Coal Mining Researches in Western Europe and their Applications in India

Prof. R. D. Singh
Associate Member

This paper reviews briefly the current researches in coal mining, carried out in the West European countries and indicates the possibilities of utilizing their findings to improve the conditions in Indian coal mines. The problems of coal mining are dealt with in three board categories : mine environment, rock mechanics and strata control, and materials and equipment.

INSTITUTION NOTICES

Misdemeanour in the Institution examinations

The Council have decided to cancel the results of the following candidates for the May 1965 examinations and debar them from appearing in the Institution examinations up to and including that mentioned against their names,

Name	Studentship No.	Roll No.	Debarred up to and including
R. Yagnarayanan	64764-S	622ST	May 1966
I. S. Sethi	48098-S	714ST	November 1966
S. C. Jayaswal	S 20394	2311A	November 1966
O. P. Ambastha	S 41033	2319A	May 1966
H. K. Mehta	S 38842	2255A	May 1966
H. L. Kapoor	S 36775	1926A	May 1966
T. S. Gupta	S 23050	1893A	May 1966
H. Singh	S 44985	1415A	November 1966
P. L. Sharma	S 27149	1098A	May 1966
Z. S. Gupta	S 11723	1079A	November 1966
Sham Dass	S 33756	1017A	November 1966
Rajinder Singh Chabal	S 45518	3845NA	May 1966
M. D. Mishra	S 57140	5304NA	May 1966
O. P. Sardana	S 44403	6367NA	November 1966
I. Sudera	S 55979	3108NA	May 1966
R. P. Mehta	S 53930	3278NA	November 1965
Davinder Singh	S 19916	3291NA	May 1966
Jahangir Chand	S 52669	3831NA	May 1966
J. L. Kapoor	S 51007	3897NA	May 1966
D. Parkash	S 53180	3505NA	May 1966
R. K. P. Singh	S 55523	3597NA	May 1966
P. P. Mukherjee	S 29023	1962NB	May 1966
D. P. Sanyal	S 27383	1963NB	May 1966
K. L. Gupta	S 34964	377NB	November 1966

Draft Indian Standards

The following draft Indian Standard has been issued recently.

Draft Indian Standard Specification for Toluene, Pure, Nitration Grade (Revision of I.S. : 537-1955)

This standard prescribes the requirements and the methods of sampling and test for toluene of pure nitration grade.

Members may send their comments on the above draft standard before January 7, 1966, to Dr. V. M. Dokras (*M.*), Director of Technical Education, Madhya Pradesh, Bhopal, who is the Institution representative in the Chemical Engineering Division Council.

Copies of draft standards may be obtained from the office of the Indian Standards Institution, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 1, or from its branch offices at 232 Dr. Dadabhoy Naoroji Road, Bombay 1; 11 Sooterkin Street, 3rd Floor, Calcutta 13; 14/69 Civil Lines, Kanpur; and 1/12 First Line Beach, Madras 1.

INSTITUTION NEWS

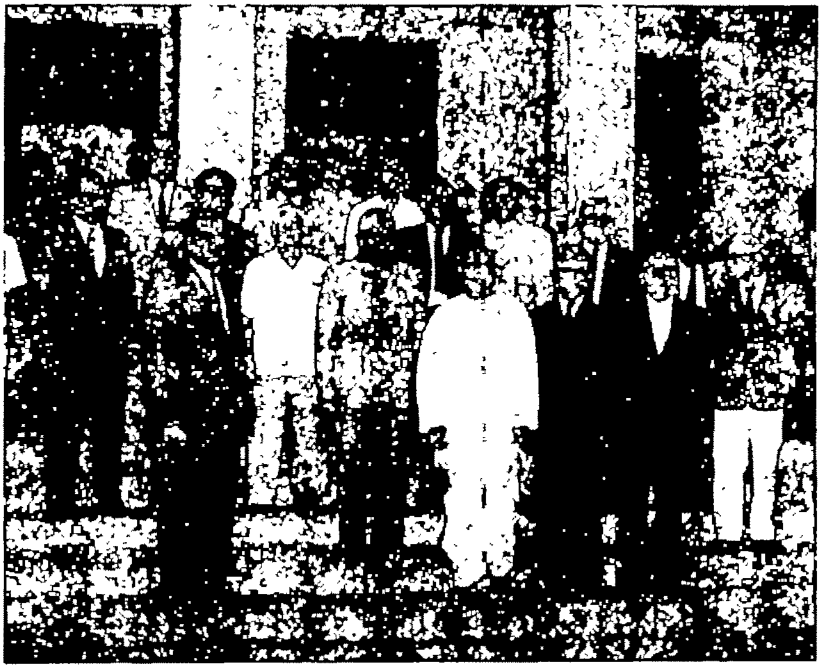
Inauguration of the Engineering Research Development and Consultancy Centre at Bangalore

The Engineering Research Development and Consultancy Centre (ERDAC) proposed by the Mysore Centre of the Institution, was inaugurated by Shri S. Nijalingappa, Chief Minister of Mysore, at the Mysore Engineers Association Hall, Bangalore, on Sunday, August 29, 1965. Prof. N. S. Govinda Rao, President, was in the Chair. The gathering, besides the Members of the Council of the Institution, included some of the distinguished engineers of Mysore who were closely associated with the Institution and the Mysore Engineers Association.

Welcoming the Chief Guest and the gathering, Shri R. A. Rajagopal, Chairman, Mysore Centre, said, 'It gives me great pleasure to welcome you all for this inaugural function of the Engineering Research Development and Consultancy Centre. The idea of a research centre at the Mysore Centre of the Institution was suggested by the Chief Minister himself and the then Governor of Mysore, His Highness Shri Jayachamarajendra Wadiyar, at the Centenary Celebrations of the Mysore Engineers Association held in 1963. When the question of amalgamation of the Mysore Engineers Association with the Institution of Engineers (India) was being considered, Shri Dildar Hussain, who was the Chairman of the Sub-Committee set up by the Institution, supported the idea of setting up the research centre. At his instance, it was agreed that one of the means of commemorating the 100 years of service by the Mysore Engineers Association was the establishment of a research and consultancy centre.

It took some time to crystallize our ideas clearly on this subject and we are happy today that the person who originally mooted the idea about two years ago is inaugurating this research centre. At every meeting of the Institution in which the Chief Minister has been participating, he has been continuously emphasizing the urgent need for constructive and creative work, and assured the necessary governmental assistance for such work. In fact, we plead guilty for the delay in getting through the organizational setup required for a centre of this type. I do not wish to amplify further on this occasion except to say that this being a research development and consultancy centre, we realize the responsibilities involved in achieving the high standard of work, which other Local Centres can emulate. I am sure that this will be possible with the very active cooperation of not only the members of the Local Centre, but experts from the other Local Centres as well as the Headquarters. The office of the Institution has with full enthusiasm contributed to the establishment of this Centre.

I thank the President, the Members of the Council, the Members of the Finance Committee, and the Secretary and his Staff, who have helped to get through this work as expeditiously as possible.'



Shri S. Nijalingappa, Chief Minister of Mysore State, with Prof. N. S. Goinda Rao, President, and members of Local Centre Committee

Following the welcome, Shri S. G. Ramachandra, Honorary Secretary, Mysore Centre, outlined the objectives and functions for which the Centre had come into being. He said, 'The Research Centre is being established according to the amalgamation of the Mysore Engineers Association with the Institution of Engineers (India). This Centre will have a shortened name, ERDAC. The Centre will work as a non-profit making body. This set up will not compete with any of the existing organizations nor duplicate the type of work done in the other research organizations in the State. The following are the objectives of the Centre:

(a) To offer consultancy services both in design and construction of civil and mechanical structures, and electrical circuits and equipment;

(b) To undertake preliminary studies and prepare feasibility reports, if necessary, on specific problems and projects referred to the Centre;

(c) To undertake the responsibility for guidance on standardization of raw materials used by the engineering industry including civil engineering industry:

  (i) To prepare proper purchase specifications, where specific standards do not exist;

  (ii) Offer advice on procurement of the right types of materials indicating even the sources of supply;

  (iii) To provide, if necessary, supervisory services for manufacturers of raw materials;

(iv) To make arrangements for qualitative inspection and testing of materials and equipment generally in use ; and

(v) Arrange for supervisory service during construction and erection;

(d) To undertake the study of soil conditions and give proper advice on foundation problems ;

(e) To undertake the development of purely indigenous designs and suggest improvements of design in existing projects for the benefit of those organizations which do not have their own development and research groups ;

(f) To offer consultancy on all aspects of engineering from amongst specialized panels of consultants who are members of the Institution ;

(g) To maintain up to date technical information and documentation ; and

(h) To train research students and other workers in the above type of work.

In fulfillment of the above objectives, a small beginning is already made. A technical secretary with the necessary staff will be incharge of the Centre.

As members are aware, the Mysore Centre has started a series of studies under the title 'Challenge of Sharavathy'. The work of coordination which the Director of Industries, Government of Mysore, has desired us to do will be undertaken by this Research Centre and entrepreneurs can make use of this facility at the Centre.

Classification of members of the Mysore Centre of the Institution based on their specialization is now under way and nearly 100 persons have forwarded information as regards their fields of specialization. The libraries of the Institution and the Indian Institute of Science, Bangalore. will be used for providing the necessary technical information and documentation. The cooperation of the Mysore Small Scale Industries Association have already been enlisted for undertaking work on specific projects. One or two projects are already underway. These pertain to the quality of indigenous raw materials and proper training of local labour for specialized skills. Cooperation of the Chief Engineers of the Government of Mysore, the Mysore Electricity Board and the Mysore Chamber of Commerce in the working of this Centre. has been assured Another project which the Centre will be undertaking at the suggestion of the Chief Minister pertains to the subject of low cost housing and school buildings. The Government Architect is actively cooperating with the Institution in this work and within the next 2-3 months we will be able to make concrete suggestions to the Government on this subject.

In this connection, it is necessary for me to record the cooperation the Institution has been receiving from the Public Works Department of the State, the Mysore State Electricity Board, the Bangalore Water Supply and Sewage Board, many other Governmental agencies and the industrialists in the State in the various activities of the Institution. We are shortly planning a Seminar on 'The Problem of Industrial Wastes', in collaboration with the Bangalore Water Supply Board. The Director of Employment and Training, Government of Mysore, is encouraging us in developing the courses of study and syllabus for training masons, carpenters and fitters for the building industry.

Shri R. A. Rajagopal, Chairman, Mysore Centre, welcoming the audience

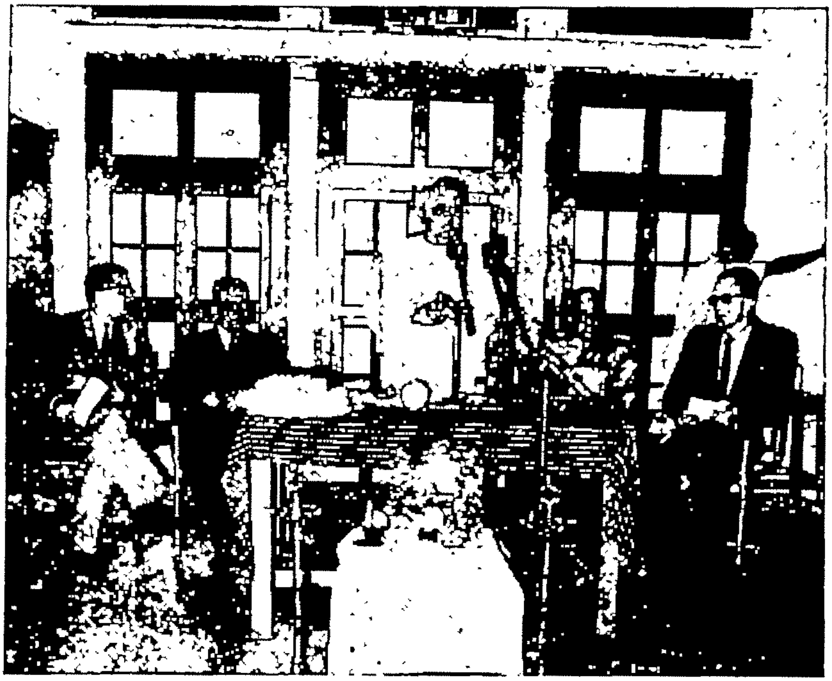
The work of drafting a syllabus for the training of masons is just complete and the Institution's recommendation is being forwarded to the Government in a week's time.

In order to educate and guide public opinion properly on the question of tariffs for public services such as electricity tariffs, it is proposed to hold a symposium to give a background of engineering economics to the consumers. In the same symposium, the consumers' views will be heard and it is proposed to submit a memorandum to the Tariff Committee based on the views expressed at the symposium.

We have many other ideas which we would like to try out with the object of bringing about purposeful cooperation between the various agencies in the State.

The Institution feels that in a developing economy its role as a coordinator is more keenly felt today than ever before. We are glad to record the positive cooperation and the assurances of assistance from the Government for this work'.

Inaugurating the Research Centre, Shri S. Nijalingappa, Chief Minister of Mysore, said, such centres are essentially required at the present juncture when it was very difficult for both the Government and the people to spare huge sums of money for school buildings. Research is the basis of all progress. It was the duty of the Government and the society to find out the talent among young scientists and engineers and encourage them to carry on their research. He added that he was proud of Mysore engineers. In fact, it was the late Dr. M. Visvesvaraya, the engineer-statesman, who laid the foundation for planned development and progress. Emphasizing again that research was the basis of progress, he called upon engineers to be in the vanguard of research. He wanted them to devise ways of constructing low cost houses and school buildings. 'We cannot afford to spend Rs. 70,000 for a school building', he said. He stressed the need to encourage young engineers and scientists.



Shri S. Nijalingappa, Chief Minister of Mysore State, inaugurating the Research Centre

Prof. Govinda Rao dealt at length on the importance and role of research in human service and added that the State was fortunate to have a Chief Minister who is so keenly aware of the innumerable benefits research would bring in and has been doing all that is possible to help the cause. He assured the Chief Minister that the Research Centre would give all attention to research on the economics of engineering projects.

Shri B. Seshadri, Secretary of the Institution, proposing the vote of thanks and said, 'It is my privilege now to propose a vote of thanks to our Chief Guest, who has so kindly inaugurated this Research, Development and Consultancy Centre this morning. As the original suggestion for its establishment had come from him, it has been very appropriate that he has seen its fulfilment.

The founding of this Research Centre represents a unique advance in the activities of the Institution, which have been following out in a number of new directions in recent years. It has come into being, also, through a unique event. This event was the amalgamation of the Institution with an even older body of engineers, the Mysore Engineers Association, which had a fascinating history, a history of service, stretching back to a hundred years.

With the assured and gracious support of the Chief Minister and his Government, the Research Centre has a great future and important duties to carry out.

May I request you all, gentlemen, to show our appreciation to the Chief Minister for all he has done for the Institution and the engineers, and for being with us this morning in the usual way?'

SEATO Graduate School of Engineering Scholarships

Scholarships are awarded by the SEATO Graduate School of Engineering, Bangkok, Thiland, for study leading to the degree of Master of Engineering in hydraulics, public health, soil, structural, or transportation engineering. These scholarships are available to selected graduate students who are nationals of Brunei, Burma, Cambodia, Ceylon, India, Indonesia, Laos, Malaysia, Pakistan, Philippines, Singapore, South Vietnam and Thailand. A full scholarship for students outside Thailand includes: (i) minimum cost air travel from residence to Bangkok and return, plus an allowance of 500 Baht toward fees charged in connection with entering Thailand, (ii) subsistence allowance of 1,500 Baht per month, (iii) tuition, (iv) textbooks used in courses taken for credit, and (v) research and other thesis expenses.

The application for admission from eligible applicant is also considered as an application for a scholarship. Application forms can be obtained from the Dean of the Graduate School and should be returned to him before February 15, 1966, for consideration of an award starting with admission in June 1966.

Proceedings of the Symposium on the Application of Prestressed Concrete to Machinery Structures, London, January 1964

In January 1964, the Prestressed Concrete Development Group of the U.K. organized a Symposium on the Application of Prestressed Concrete to Machinery Structures, on behalf of the Committee set up to study this subject by the Federation Internationale de la Precontrainte. The proceedings of this Symposium have now been published by the Prestressed Concrete Development Group. This 40 page publication, in A4 format, contains over fifty photographs, drawings and diagrams. The *Proceedings* contain papers given by engineers from Britain, Germany and Russia dealing with the application of prestrssed concrete to machinery frames, foundations for turbo-alternators in power stations, structures which are subject to shock loading, foundations for heavy plant, and triaxially prestressed bedplates for heavy frames. The use of prestressed concrete for machinery structures is an almost entirely new field in which there is a tremendous potential for development. Since the Symposium held in 1964 was the first of its kind, this publication is of particular importance. The publication is available at a cost of £ 1.5.0d. from the Prestressed Concrete Development Group, Terminal House, Grosvenor Gardens, London, S.W. 1, England.

Proceedings of the Symposium on 'Systems Engineering for Control System Design', Tokyo, August 1965

The *Proceedings* of the IFAC Tokyo Symposium on 'Systems Engineering for Control System Design' held in August 1965 will be published by the Symposium Committee. The reduced post-paid price is $ 13.10 which will be in effect till

November 30, 1965. After this date the price of the *Proceedings* will be $ 15.30. Order forms can be obtained from Technical Officer (Scientific), The Institution of Engineers (India), 8 Gokhale Road, Calcutta 20.

Subscription rates for I.E.E. publications and Transactions of the E.I.C., 1966

The annual subscription rates applicable to members for the publications of The Institute of Electrical Engineers, London, are given below.

Title of publication	Subscription rate
Electronics and Power	£ 3.15.0
Proceedings	£ 9. 0.0
Electronic Record	£ 4.14.6
Power Record	£ 3. 0.0
Science and General Record	£ 3. 0.0
Science Abstracts Section A	£ 18.15.0
Science Abstracts Section B	£ 13. 2.6
Students Journal	£ 0. 9.6
Current Papers in Electrical Engineering	£ 1.10.0
Current Papers in Physics	£ 3. 0.0

The *Transaction of the Engineering Institute of Canada* are published in the following series : A Bridge & Structural, Civil, Geotechnical ; B Mechanical, Thermal and Nuclear Power, Welding ; C Communications & Electronics & Automation, Electrical, Hydro-electric ; D Education , Management, Research ; and E Chemical, Mining & Metallurgical, Oil & Natural Gas. An annual subscription rate of $ 3.00 will entitle a member to all the above series to be published during 1966.

LOCAL CENTRE ACTIVITIES

Mysore Centre

A new Tariff Committee was constituted by the Mysore State Electricity Board for reviewing the tariff structure in the State, and a preliminary meeting was held recently for ascertaining the views of the industrialists and consumers in the question of revision of power tariffs. The Mysore Centre was also invited to the meeting to give the Institution's suggestions in the matter. Shri S. G. Ramachandra (*A.M.*), Honorary Secretary, and Shri J. L. D'Sa (*M.*), Joint Honorary Secretary of the Centre attended the meeting and a summary of the suggestions made by them is given below.

Background

Over the last ten years power tariffs have been revised three times, first in 1956 based on the recommendations of the Thacker Committee, then in 1959 based on the recommendations of the Iyengar Committee, and again in 1963 based on the recommendations of another Committee headed by Shri N. N. Iyengar. Each of these revisions have shown an upward trend in tariff rates. Also, during this period, electricity duty has been imposed which at the moment is one of the highest in India. However, during the last ten years, there has been an increase in installed capacity of 95 MW only. The units sold during the same period have approximately doubled and the load factor has improved to about 73%. In the same period, the system cost per kW installed has almost doubled, whereas the operation and maintenance expenses per unit sold have also doubled. This has increased the cost per unit by 50% and the revenue realized per unit has also increased by 50%. In the light of the above figures, the increase in tariff over the period of ten years was necessary.

Nature of industry

The Electricity Boards were constituted in pursuance of the provisions of the Electric Supply Act, 1948, with the specific object of promoting the coordinated development of generation, transmission and distribution of electricity in the most efficient and economic manner. The returns should be adequate to meet (i) operation and maintenance charges ; (ii) contribution to depreciation and general resources ; and (iii) payment of interest charges on capital employed and, if possible, to earn more to finance extension activities. The Institution recognizes that there is an inflationary tendency in the country both on cost of equipment and wages. Purely from a technological point of view during the last forty years, generator sizes has risen from 5,000 kW to 90,000 kW. In the last stage of development in the State, the increase in generator size is more than five times. This, the Institution believes, has for the first time given a break through as far as the cost of generation is concerned. Therefore, in keeping with the trends in other countries, the consumer has been hoping for a reduction in power tariff. A study of systems operation in other countries gives a clue to this. The Institution therefore hopes that the Mysore State Electricity Board will meet the challenge to improve its operational efficiencies and service to the customers and thereby achieve reduced costs of operation. The benefit could then be passed on to the consumer.

The Mysore State Electricity Board has a capital outlay of Rs. 86 crores, its working expenses are also Rs. 340 lakhs. The revenue per unit sold was expected to be 6.3 P. and the pattern of consumption and revenue were to be as follows :

Consumption	Units,%	Revenue,%
General lighting and domestic power	10.3	34.28
Agricultural pumps	4.28	4.85
L.T. consumers (industries)	7.67	13.52
Street lights	3.06	7.05
H.T. supply	74.40	38.17

It would be interesting to note how the actual figures compare with the anticipated figures. The revenue realization was expected to cover the operation and maintenance charges and depreciation, and leave a small deficit. It is presumed that the Boards in general cannot endeavour to create resources to finance the capital expenditure.

With the commissioning of the Sharavathy, it would be futile to expect an immediate return on the capital block invested in the project. A certain time lag will have to be allowed for the demand to build up. The block of power is so large that it may take a few years before the state consumes the entire energy. The losses during the first few years will necessarily have to be capitalized. As against this approach, if the Board were to purchase power from the Government at a rate which does not make sufficient provision for the time required for the load growth, the purchase price will be high and the tariff will necessarily have to be pushed up. This will act as an handicap to the overall socio-economic development of the State.

Promotional tariffs

As the State is anxious to increase the tempo of industrialization, every endeavour should be made to keep the tariffs as low as possible and if reduction of tariff is not possible immediately, the Board should seriously attempt to find out ways and means of keeping the present tariff rates going for another three years, at the end of which period it may be possible for the Board to reduce the tariffs. The capacity of the consumer to pay and the purpose for which power is to be utilized are the two factors that should govern the tariffs. The cost of the power element in the total cost of the end product is a very important consideration even if this cost forms a small percentage.

Rural electrification

In a socialistic pattern of society, it is very necessary that benefits of electricity should be made available to the rural areas as fast as possible. The Government is rightly very keen on this extension activity. Because of the very nature of the off-take, this programme of rural electrification cannot yield adequate returns and will thus act as a liability on any electric supply company. The load growth is slow in rural areas. A time lag of 7 to 10 years will be needed to ensure a fair return. This aspect has been studied by the Venkataraman Committee and it has made a positive recommendation that the Government of India should explore the possibility of granting loans for rural electrification schemes which should be interest-free during the first five years. Unless this is done, the progress in rural electrification can be achieved only by transferring this burden to other classes or consumers and thereby arresting their growth.

The Institution attaches greatest importance to Recommendation 9 of the Venkataraman Committee. This can be achieved by (i) lowering the cost of electricity purchased; (ii) minimizing the administrative expenses; (iii) lowering the working expenses; (iv) reducing the billing expenses; (v) lowering the interest charges on capital, and (vi) improvement in transmission and distribution losses. The Board should constitute a cost study cell for this specific purpose.

The Institution is willing to undertake a detailed study of any particular aspect of the technical problems for the Board. A sample survey to study system losses, voltage and service conditons with a view to improve the efficiency of service may be suggested. In the absence of detailed figures on the various technical aspects of system operation, the Institution is unable to give any positive recommendation on this aspect immediately. As stated earlier, the Institution will be pleased to undertake this work in their new consultancy and research centre.

Electricity duty

This tax was introduced in Mysore State in 1957. The average rate of tax on consumption was 0.558 P. per unit. In 1964, the average rate of tax was 1.36 P., *i.e.*, an increase of 144%. This increase is highly disproportionate to the increase in the tariffs during the period.

To enable the Board to evolve promotional tariffs for power consumption, the tax or the duty should not take away this important feature. Electricity is not a luxury to the common man and has become essential to maintain his present living standard. The Institution is of the firm opinion that the State Government should reduce the tax burden. On a comparative study, it is seen that the tax burden in the State of Mysore is the highest, *viz.*, 3.6% on loan capital, as compared with 1% in Maharashtra, 1.4% in Madras, 0.1% in Kerala, and 0.5% in Bihar. In the case of a particular class of consumer such as domestic consumers with an all-electric home, the incidence of tax is as much as 25% of the monthly consumption. There is thus great scope for reduction in the tax and make it on an *ad valorem* basis as suggested by the Venkataraman Committee.

Comments on existing structure

As pointed out earlier, all efforts should be made to continue the existing rates for power. A few points for rationalization are suggested. As far as domestic consumers are concerned, the outlet system may be discontinued to encourage the consumer to use more outlets and therefore more power. A minimum of such consumers may be taxed on the basis of an agreed sanctioned load. In rural areas, a common tariff for all types of consumption may be considered in order to reduce the installation costs.

Service improvement

There have been a number of dissatisfied consumers. The main complaints which need immediate attention are : (i) voltage conditions ; (ii) continuity of service and dividing frequent interruptions ; (iii) undue delay in attending to complaints ; and (iv) undue delay in servicing sanctioned new installations. The Institution feels that the Board should undertake an overall drive to improve its services. This by itself will encourage load growth and provide reveneue stability. In the absence of proper load growth and revenue stability, it will be difficult for any tariff committee to decide what tariffs will be suitable for the next five years.

The Institution also feels that the tariffs fixed in 1965 should be in force for at least five years, during which period promotional tariff for industrial development would encourage a rate of load growth which would bring in better revenue. The existing rates have this advantage.

Public relations

The Board at present does not have any organized public relations efforts. This is an immediate necessity to propagate the use of more power and give publicity for the good work and improvements done by the Board in the interest of consumers. The safety aspects also need emphasis periodically. Periodical conferences with contractors and manufacturers of electrical equipment will bring about better coordination.

FORTHCOMING CONFERENCES

Symposium on 'Problems of Energy Supply in India during the Fourth Five Year Plan', Central Fuel Research Institute, February 4-5, 1966

The Indian Section of the Institute of Fuel, London, in collaboration with the Central Fuel Research Institute, is organizing a Symposium on 'Problems of Energy Supply in India during the Fourth Five Year Plan' at Jealgora, Dhanbad, from February 4 to 5, 1966. Papers are invited by the Chairman of the Indian Section of the Institute of Fuel and the titles and the summaries of which should reach him by December 20, 1965.

Further information can be obtained from Dr. A. Lahiri, Chairman, Indian Section of the Institute of Fuel and Director, Central Fuel Research Institute, P.O. F.R.I., Dhanbad, Bihar.

Third Symposium on Earthquake Engineering, University of Roorkee, November 1966

The Third Symposium on Earthquake Engineering will be held at the University of Roorkee in November 1966. The subjects for discussion at the Symposium include :

(i) Analysis of structural response and design of structures for earthquake forces,

(ii) Design of dams and other appurtenant works in seismic zones,

(iii) Soil and foundation behaviour during vibrations,

(iv) Seismicity, wave propagation and ground motion,

(v) Instruments for earthquake engineering and seismological studies,

(vi) Geological studies of tectonic features influencing occurrence of earthquakes,

(vii) Recent strong earthquakes and resulting damage, and

(viii) Housing in seismic zones.

Papers accepted for the Symposium will be printed and distributed to all registered participants before the opening of the Symposium. Members who wish to contribute papers should intimate the titles to the University before March 31, 1966.

Further particulars can be obtained from Dr. Jai Krishna, Professor and Director, School of Research and Training in Earthquake Engineering, University of Roorkee, Roorkee, Uttar Pradesh.

International Symposium on Generalized Networks, New York City, April 12-14, 1966

A Symposium on 'Generalized Networks' is organized by the Polytechnic Institute of Brooklyn, in cooperation with the Institute of Electrical and Electronics Engineers, the Optical Society of America and the Society for Industrial and Applied Mathematics, to be held in New York City from April 12 to 14, 1966. The suggested topics of particular interest are: (i) Network theory of distributed structures; (ii) Network representations in electromagnetic theory, (iii) Optical systems as networks, (iv) Translation of physical laws into constraints on network realizability, (v) Networks as thermodynamic system, (vi) Network formation in quantum mechanical systems, (vii) New attacks on classical network problems, and (viii) Network representations of biological systems.

Contribution of papers is welcomed by the Symposium Committee and the last date is January 1, 1966. Further information can be had from the Symposium Committee, Polytechnic Institute of Brooklyn, 333 Jay Street, Brooklyn, New York 11201, U.S.A.

1966 British Joint Computer Conference, Eastbourne, May 3-5, 1966

The 1966 British Joint Computer Conference will be held at Eastbourne from May 3 to 5, 1966. Sponsored by The British Computer Society, The British Institute of Management, The Institute of Chartered Accountants, The Institution of Electrical Engineers, The Institution of Electronic and Radio Engineers, the Conference will be held under the aegis of The United Kingdom Automation Council. The scope of the Conference has been provisionally divided into the following categories:

1. Scientific Applications
   (a) Combinatorial problems (*e.g.*, scheduling, assignment and timetabling problems),
   (b) The use of computers for engineering design.
2. Management Planning and Decision Making
   (a) Resource utilization.
   (b) Network analysis
   (c) Business control at all levels (including production control).
   The interaction between the design of computer systems (hardware/software) and the needs of the user.
3. Current Problems
   (a) How does the systems engineer propose to meet the requirements of the user?
   (b) How does the user propose to accommodate the limitations of the system.
4. The Engineering of real time systems
5. Future horizons

The Organizing Committee will welcome offers of contribution of up to 3,000 words (or six pages of A4 typescript and diagrams, etc.) for consideration for inclusion in the Conference programme.

Further details can be obtained from The Conference Secretariat, I.E.E., Savoy Place, London, W.C. 2.

Symposium on 'Test Methods for Compression Members', Atlantic City, June 1966

The Column Research Council and the American Society for Testing and Materials are sponsoring a Symposium on 'Test Methods for Compression Members', to be held at the ASTM Annual Meeting, Atlantic City, New Jersey, U.S.A., in June 1966.

The purpose of this symposium is to bring to light and summarize information on test methods. testing techniques and analyses of experiments involving the stability of structural members. The mechanical behaviour of columns, beams, plates, shells and stiffened panels is strongly influenced by the boundary conditions, nature of the loading, material properties and characteristics of the test specimen. Failure to understand and to take account of and properly control these factors has often led to wasted experimental effort.

It is expected that information obtained and disseminated through this symposium will help the neophyte to avoid some of the common mistakes in compression testing—particularly when the specimen is subject to buckling. Also, that it will assist the experienced research worker in his studies and applications of materials and research to new areas of structural behaviour.

Papers are invited on all aspects of compression testing. Particular areas include centrally loaded columns, columns under combined thrust and bending, methods of predicting buckling loads, lateral buckling of beams, materials testing, alignment of specimens, plates, thin shells, effects of response of testing machines, pressurized shells with external loading, creep buckling, similitude in instability testing and others. The deadline for offers is October 9, 1965. Abstracts, not to exceed 300 words, should be sent as soon as possible to: K. K. Irwin, EM 219, National Bureau of Standards, Washington, D.C. 20234, U.S.A., from whom further details of the symposium can also be obtained.

3rd International Conference on Water Pollution Research, Munich, September 5-9, 1966

The Third International Conference on Water Pollution Research will be held in Munich, Germany, from September 5 to 9, 1966. The third in a series, the Conference is designed to report and record current outstanding research in water pollution control from all parts of the world. The First Conference was in London in 1962 and the Second Conference in Tokyo in 1964. The technical programme consists of three research symposia of 16 papers and approximately 32 discussions each:

(i) Freshwater pollution;

(ii) Waste treatment; and

(iii) Marine disposal.

Further information can be obtained from 3rd International Conference on Water Pollution Research, Box 1907, Washington, D. C. 20013, U.S.A.

Sixth International Conference on Microwave and Optical Generation and Amplification, Cambridge University, September 12-16, 1966

The Sixth International Conference on Microwave and Optical Generation and Amplification, sponsored by the Electronics Division of the Institution of Electrical Engineers, will be held at the Cambridge University from September 12 to 16, 1966. The Conference will aim to stimulate the exchange of ideas on the research which will have taken place (since the Fifth Conference in Paris in September 1964) in the fields of microwave and optical generation, amplification and other active processes. Contributions on recent outstanding scientific and technical progress in these fields will be presented and discussed.

The programme will cover microwave and optical generation by solid state, plasma and other active devices, as well as by the classical forms of microwave tubes. In addition, it will include the application of various principles and phenomena relevant to the generation and amplification of coherent electromagnetic waves without strict frequency limitation.

Intending contributors will be required to submit 250 word abstracts of their proposed papers by May 1, 1966. More complete details will be announced later.

Further details can be obtained from The Conference Secretariat, I.E.E., Savoy Place, London W.C. 2.

Conference on High Voltage D.C. Transmission, London, September 19-24, 1966

The Power Division of the Institution of Electrical Engineers will be holding a Conference on 'High Voltage D.C. Transmission' at the Manchester College of Science and Technology, Manchester, from September 19 to 24, 1966. The programme will comprise four days of technical sessions and two days of technical visits. The technical sessions will include discussion on (i) High voltage D.C. supply schemes, (ii) Plant, equipment and connections, and (iii) Sub-stations, overhead lines and cables.

Further information can be obtained from The Secretary, The Institute of Electrical Engineers, Savoy Place, London, W.C. 2.

Conference on Acoustic Noise and Its Control London, January 23-26, 1967

The Electronics Division of The Institution of Electrical Engineers, The Institution of Electronics and Radio Engineers, The Institution Electrical and Electronics Engineers, The Institute of Physics and the Physical Society, and The Society of Acoustic Technology will sponsor jointly a Conference on 'Acoustic Noise and Its Control' to be held at the Institution of Electrical Engineers between January 23 and 26, 1967. The range of topics to be discussed will include (i) Noise and the ear, (ii) The analysis and measurement of noise, (iii) Machinery noise and its control, and (iv) Noise in building.

The Organizing Committee invites offer of contributions up to 1,500 words for consideration for inclusion in the Conference Programme. The texts of contribution should be submitted before September 30, 1966, but in the first place intending contributors should send a summary (approximately 250 words) by June 30, 1966.

Further information can be obtained from The Joint Conference Secretariat, I.E.E., Savoy Place, London, W.C. 2.

Conference on Prestressed Concrete Pressure Vessels, London, March 1967

A four-day Conference on 'Prestressed Concrete Pressure Vessels' will be held in London in March 1967 under the auspices of The Institution of Civil Engineering. Jointly sponsored by the Joint British Committee for Stress Analysis and the British Nuclear Engineering Society, the Conference will consider the following broad categories :

Design philosophy and safety
Review of current practice
Properties of concrete and prestressing materials
Theoretical analysis of vessels
Structural design of vessel liners
Insulation and cooling
Model testing and experimental work

Papers on these subjects are invited from specialists and synopsis of contributions must be sent to the Technical Officer (Scientific) at the Headquarters immediately. Papers for the Conference will be required by June, 1, 1966, and should normally be of 5,000 words and not exceed 8,000 words.

Further details can be obtained from the Secretary, The Institution of Civil Engineers, 1-7 Great George Street, Westminster, London, S.A.1.

Second International Conference of Women Engineers and Scientists, Cambridge, July 1-9, 1967

The Second International Conference of Women Engineers and Scientists will be held at Cambridge, England, from July 1 to 9, 1967. It is sponsored by The Women's Engineering Society, London. The theme of the technological sessions of the Conference will be 'Enough for Every One—The Application of Technology to World Food Problems'. Since almost every branch of engineering and science is involved in some way in the production of food, this Conference can be expected to attract a wide range of technologists. The Conference has also a social theme—'The Women Professional Engineer'—in which the position of professional women engineers throughout the world will be surveyed.

The Conference Organisers are inviting offers of papers to be presented at the Conference, firstly in the form of short abstracts to be submitted before December 1, 1965. Further particulars may be obtained from the Honorary Secretary, Mrs. I. H. Hardwich, AEI Power Group Research Laboratory, Trafford Park, Manchester 17, England.

BOOK ACKNOWLEDGMENTS

1. **Elements of Dock and Harbour Engineering.** H. P. Oza. *Charotar Book Stall,* Anand, Rs. 7.50. 234 papers.

There are very few books on dock and harbour engineering and this book is the outcome of the author's experience in construction and design office. Fundamental concepts are presented and derived, and empirical formulae are given with the underlying assumptions. An attempt has been made to deal with the aspects of the subject covering the syllabus for engineering degree courses in Indian universities and the membership examinations of professional institutions.

2. **Worked Examples in Metric System of Units for Engineering Students.** V. V. L. Rao. *Tech India Publications,* New Delhi, Rs. 7.50. 189 pages.

This book contains 217 problems covering applied mathematics, physics and chemistry, civil, mechanical, electrical and electronics engineering and acoustics with solutions.

3. **Workshop Technology and Practice.** M. L. Gambhir. *Jaswant Publishing House,* Ludhiana, Rs. 9.00. 319 pages.

This book covers the syllabi in workshop technology and practice for the engineering diploma courses of the All-India Council of Technical Education, Industrial Training Institutes, Craft Centres, and engineering degree courses.

4. **Work Book in Machine Drawing.** S. D. Aggarwal. *Jaswant Publishing House,* Rs. 7.50. 128 pages.

This book is designed to serve as an exercise book for the student of engineering drawing.

5. **Work Book in Descriptive Geometry.** S. D. Aggarwal. *Jaswant Publishing House,* Rs. 10.00. 86 pages.

This book will be useful as an exercise book.

6. **Management in Civil Engineering.** E. A. Parsons, D. M. O' Herlihy and R. H. Rowe. *E. & F.N. Spon Ltd.,* 42s., 150 pages.

The civil engineer must understand not only the mathematics underlying construction but also the social milieu in which he works. He must be able to control men in organizations as well as the physical materials. Just as ignorance of the latter may be disastrous, so ignorance of the finer details of procedure in dealing with the various bodies to be coordinated in a civil engineering project retards its progress and diminishes the likelihood of proper success. This book appeals not only to civil engineers in practice, but also to those to start and to students, trainees and apprentices at most levels in the educational structure.

7. **Vibrations.** K. Magnus. *Blackie and Son Ltd.,* 65s. 299 pages.

This book on advanced vibration theory covers a range of special aspects not previously available in a single volume. A basic feature of the book is the classification of the various types of oscillatory systems according to their originating mechanisms.

As the science of oscillations is related to practically every branch, this book covers the principles of vibration including systems having infinite degrees of freedom of vibration, and deals with machine tool systems, the use of absorbers and dampers and and summarises the results obtained by research. Engineering students in their final year at universities and institutes of technology will find this book useful and production and tool engineers will find it as a source of information to keep abreast of developments.

8. **Machine Tool Vibrations.** S. A. Tabias. *Blackie and Son Ltd.*, 65s., 351 pages.

Developments in machine tools during the past few decades have raised a growing number of vibration problems. Every designer who has a machine tool in the development stage is concerned with its vibration behaviour, and every production engineer is fully aware that vibration leads to shorter tool life, poorer surface finish on the work produced, and lower output.

9. **Fundamentals of Engineering Mechanics.** L. Levinson. *Gordon and Breach Science Publishers*, New York, $ 10.50. 350 pages.

This book is in two parts. Part 1 deals with theoretical mechanics beginning with elementary statics, kinematics and dynamics, and Part 2 with the theory of machines and fundamental concepts of strain and strength of materials. The emphasis throughout is on the connection between mathematical analyses and physical facts. The examples taken from mechanical oscillations are worked out by exact mathematical methods. This is both a textbook and a work of reference for advanced students, engineers, physicists and applied mathematicians engaged in research.

10. **Mathematical Analysis of Observations.** B. M. Shchigolev. *Iliffe Books Ltd.*, 63s. 350 pages.

This book is divided into five parts. The first part deals with operations on approximate numbers and with methods of approximations. The second part discusses point interpolation of tabulated functions, which by the nature of things are subject to error. In evaluating any series of experimental measurements attention must be paid to the possibility of random errors and in analyzing measurements containing such errors, resort must be made to the theory of probability, which is also necessary in statistical work. This is the subject of Part 3, which amongst other topics includes the Chebyshev-Markov lemma and the theories of Bernoulli, Laplace, and Lyapunov. Following logically from this, Part 4 deals at length with the theory of random measurement errors. Part 5 deals with the analysis of statistical material. This book should be of great value to scientists and advanced technologists, and of great interest to statisticians.

PUBLICATIONS RECEIVED

A copy of a book entitled 'From Semaphore to Satellite' has been received from the International Telecommunication Union, Geneva. This volume published on the occasion of the Centenary of the International Telecommunication Union (ITU) is the outcome of a decision taken by the ITU Administrative Council at its 1963 Session. The Union is the oldest of the inter-governmental organizations which now form the specialized agencies of the United Nations. International cooperation in telecommunications started from small beginnings in Paris on May 17, 1865, when the International Telegraph Union was founded. Probably the most remarkable advance of the last hundred years lies in the speed and variety of our communications. First the telegraph and the telephone, then the radio, including broadcasting and television; all tremendously expanded through the electronic revolution, and now space communications, these are all an integral part of the exponential growth of science. This book traces the history of the development of the communication systems with illustrations. The achievement of successfully working together for a hundred years is uniquely presented and the need for greater cooperation in the space age is stressed.

A copy of the Annual Report 1964-65 of the Central Building Research Institute, Roorkee, has been received. The Central Building Research Institute has completed twelve years of its existence in the service of the building industry. This report presents a summary of the work of the Institute during the year.

A copy of the Survey Report No. 5—'Research Efforts in Industrial Establishment in India' has been received from the Survey and Planning of Scientific Research Unit, C.S.I.R., New Delhi. This report, compiled by S. H. M. Husaini, A. Ghoshal and A. Rahman of the Survey and Planning of Scientific Research Unit, C.S.I.R., deals with the personnel employed in industrial establishments, expenditure on financing of research, training facilities and collaboration with national laboratories, research activities of industries and foreign collaborations.

A copy of the 'Mechanical Engineering Directory and Buyers Guide 1965-66' has been received from the British Mechanical Engineering Federation, 25 Victoria Street, London, S.W. 1. The contents of the directory are divided into five sections giving (i) Buyers' guide and multilingual glossaries, (ii) Information on manufacturers' products, (iii) Directory of manufacturers, (iv) Trade names and marks, and (v) Advertisements of manufactures.

A copy of the Annual Report 1965 of the Column Research Council, Department of Civil Engineering, University of Illinois, U.S.A. has been received. This report summarizes the progress of the Column Research Council in the year 1964-65.

A copy of a brochure entitled 'Research Worldwide' has been received from the Manager, Publications-Public Services, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio, U.S.A. This brochure gives some details of the role played by the Battelle Memorial Institute, dedicated to the advancement of science. The Manager of Publications-Public Services announces that copies of this can be obtained from him on request.

A copy of a booklet entitled 'Failures in Foundations' by Dr. J. Feld has been received from Soiltest, Inc., Evanston, Illinois, U.S.A. This booklet is one in a series of manuals published by Soiltest, Inc. for the purpose of underscoring the importance of engineering testing prior to and during construction. In this booklet, the wisdom and economics of engineering testing and proper foundation design are stressed.

A copy of a publication entitled 'Iron and Steel in India 1963/64' has been received from K. K. Roy (Private) Ltd., 55 Gariahat Road, Calcutta 19. Priced at Rs. 15.00 per copy, this publication is divided into two sections. The first section contains articles on the importance of iron and steel industry in Indian economic development and the later section deals with the status of the industry in Australia, Austria, Belgium, Sweden, the U.S.A. and the U.A.R.

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, industrial and other organizations employing engineers. It is hoped that employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

SITUATIONS WANTED

YOUNG ELECTRICAL ENGINEER, age 28, passed B.Sc. examination of the Calcutta University, possessing first class diploma in electrical engineering, and passed Sections A and B of the Associate Membership Examination of the Institution of Engineers (India) in electrical engineering, having 4 years experience in a big railway workshop, in armature winding, motor overhauling, thermal power station, electric instruments and meters, installation of substation, maintenance of electric installation in residential, office building and workshop ; also one year experience in A.C. electric traction overhead distribution in the Railways, seeks suitable change. (Office ref. E.S. 211)

Qualified and foreign trained power transformer Designs and Calculations Engineer with 9 years experience seeks a change in high voltage power transformer or similar line. Expected salary Rs. 1,500 p.m and perquisites. (Office ref. E. S. 212)

YOUNG ENGINEER, age 25, student of the Institution of Engineers (India), possessing Electrical Supervisor's Licence with first class Diploma in Electrical Engineering securing 70.3% marks, having 4½ years experience in teaching in a polytechnic, supervision, and maintenance of electrical machines, installations, etc., holding class II Gazetted post; seeks change in Government or private organization anywhere in India; minimum gross salary expected in suitable grade Rs. 450.00 p.m. plus D.A. and T.A. if the post is touring one. Office ref. 213)

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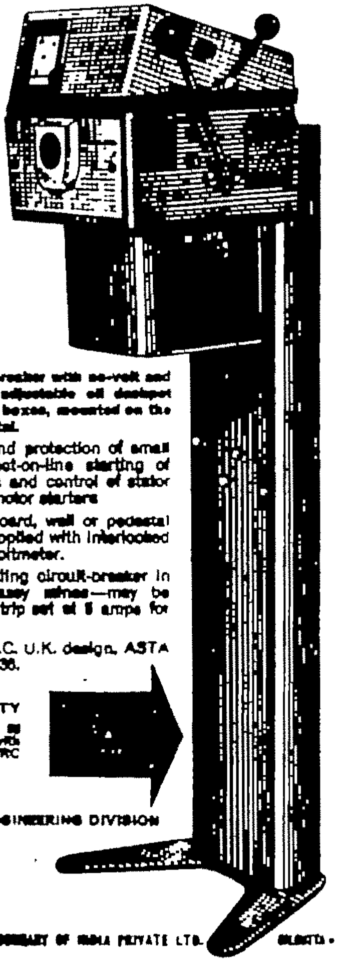

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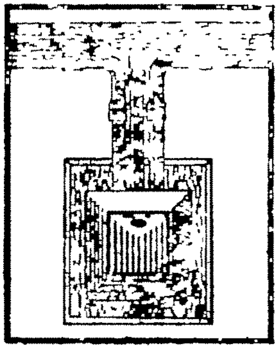

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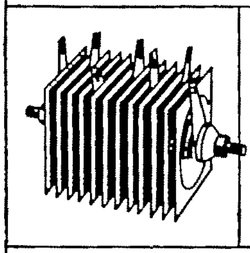

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OF
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SHRI B. P. KAPADIA, M.I.E.
PRESIDENT-ELECT, SESSION 1966-67

SHRI B. P. KAPADIA, PRESIDENT-ELECT, 1966-67 —A BRIEF LIFE-SKETCH

Shri B. P. Kapadia, M.I.E., President-Elect for the session 1966-67, will take over office as President from Prof. N. S. Govinda Rao, M.I.E., retiring President, at the inaugural ceremony of the 46th Annual Convention to be held at Patna on Monday, January 31, 1966, in the distinguished presence of Shri Y. B. Chavan, Union Minister for Defence, who has kindly accepted to inaugurate the Convention.

Shri Beramshaw Pherozeshaw Kapadia, B.E., M.I.E., an outstanding figure in Indian engineering, has been elected President of the Institution for the session 1966-67. Shri Kapadia joined the Institution as an Associate Member in 1923 and was transferred to Member in 1938. He has been a member of the Council of the Institution for five years and was Chairman of the Bombay Centre in 1956-57, besides having served on the Committee of that Centre over a long period of years.

Born in Broach in October 1890, Shri Kapadia was educated in Broach High School and the Wilson College, Bombay, where he was a scholarship holder. He joined the College of Engineering, Poona, and took his B.E. degree in Civil Engineering from that College in 1916.

After a year's apprenticeship in a firm of architects, he was appointed as State Engineer in a Princely State. He also worked later in McKenzie Ltd., Bombay, specialising in reinforced concrete development. In 1920 he joined Marsland and Price Co., Bombay, which was at that time the oldest firm of R.C.C. specialists, as an engineer.

From 1920 to 1925 Shri Kapadia was responsible for all the major R.C.C. construction works and power houses for Tatas in Bombay and the adjoining areas as Works Manager of the firm. In 1926 Tata Construction Co. were appointed as Managing Agents of Marsland Price Co. and Shri Kapadia was appointed Engineer-in-Charge of the work of realignment of the Bore Ghat section of the Great Indian Peninsular Railway near Bombay, which included construction of new tunnels, embankments, bridges, etc. These were completed in 1929.

In 1929-30 Shri Kapadia carried out the difficult work of widening the existing tunnels under traffic on the Bore Ghat and Thull Ghat. From 1931 to 1934 on behalf of Hindustan Construction Co. he executed a large number of civil and reinforced concrete works including a bridge in record time in Poona. During 1934-35 he completed several large works including reinforced concrete tanks, Osmania University, bridges, and water supply schemes in Hyderabad State.

In 1936 he proceeded to Quetta after the great earthquake, and as Works Manager for the firm carried out the earthquake proof reconstruction of the entire city, work which lasted till 1939. From 1939 to 1942 he had a special assignment in Ceylon in connection with the hydroelectric project at Norton Bridge and was in charge of the construction of the concrete dam, many tunnels, pressure pipelines, power houses, etc. during the Second World War.

From 1942 he was again in charge of all works in Bombay including the Premier Automobile Works, embankment cutting for Tansa pipeline works, and all underground work of new tunnels in Thull Ghat, Igatpuri, etc.

In 1946 he became Deputy General Manager of the H.C.C. for the Bombay Zone. Along with all works in Bombay he had charge of all underground works relating to the Tungabhadra project in Hyderabad and the Maithon project in the Damodar Valley Corporation.

In 1948 he became General Manager of the Company. In the next 15 years in this high capacity his most outstanding achievements were the construction of the Koyna hydroelectric project including the underground power house, tunnels, and the difficult work of underground penstocks-tunnels, the irrigation tunnel at Bhadra, and all tunnels and R.C.C. works of the Sharavati project in Mysore State. Shri Kapadia became widely known as an authority on underground and tunnelling works. He retired as General Manager in May 1963.

From then to mid-1963 he acted as Consultant to the Hindustan Construction Co., finally retiring from the Company in September 1965. He, however, still continues to practise as a Consultant but mostly for work relating to arbitration.

Besides his connection with the Institution, Shri Kapadia has been widely connected with other engineering organisations during his long and brilliant career as a civil engineer. He has been a Member of the Building Division Council of the Indian Standards Institution and also many of its Committees. He is also a Past-Chairman of the Engineering Association of India. He is a founder-member of the Builders Association of India and was its President for four years. The Association made him an Honorary Life Member in recognition of his long and exceptional services. He was a delegate of the All-India Employers Association to the Building, Civil Engineering and Public Works Committee meetings of the International Labour Organisation, Geneva, in 1949, 1951, 1956, 1959 and 1964. At the I.L.O. Convention in 1956 he was elected Vice-Chairman of the Employers Group in the Committee. In 1965 he was nominated by the All-India Employers Association as an expert in 'Safety' to the Governing Body of the I.L.O.

Shri Kapadia is a Freemason and holds very high ranks in those institutions, and a Lion. He is connected with a large number of social organisations where his extreme outspokenness, integrity, cheerful disposition and hard work have endeared him to all. His premier relaxation is horse-racing of which he is very fond.

PROCEEDINGS OF THE EXTRAORDINARY GENERAL MEETING OF CORPORATE MEMBERS UNDER BYE-LAW 82(c), NEW DELHI, DECEMBER 3, 1965

An Extraordinary General Meeting of Corporate Members under Bye-law 82(c) was held on Friday, December 3, 1965, in New Delhi, at the Delhi Centre of the Institution, Bahadur Shah Zafar Marg, at 6.00 p.m. Prof. N. S. Govinda Rao, President, was in the Chair, and 106 Corporate Members were present.

The President said that the Notice of the Meeting had been posted to Corporate Members on November 5, 1965, and a Resolution of the Council of the Institution passed at their 441st Meeting held in Bhubaneswar on May 2, 1965, proposing revisions to Bye-laws 77 and 78 was before them.

He then read out existing Bye-laws 77 and 78 and also proposed revisions to these Bye-laws as follows :

Existing Bye-laws 77 and 78

'77. All compounding fees, received from Members and Associate Members and all admission fees shall be regularly invested, as soon as possible after the receipt thereof by the Bankers, as instructed by the Council in any one or more of the securities appearing in the List of Securities hereinafter referred to as approved Securities appended to the Bye-laws, and only the interest accruing therefrom shall be available for the general expenditure of the Institution. Such moneys and investments shall form the Permanent Reserve Fund. The Council shall be at liberty :

(a) To vary the investments at their discretion within the limits of approved securities;

(b) To deposit all or any of the securities representing the Permanent Reserve Fund with the Bankers of the Institution to secure an overdraft on current account not exceeding Rs. 50,000 at any time; and

(c) To spend any portion of the Permanent Reserve Fund in purchasing land, buildings, furniture and equipment for the Institution or any Local Centre or Sub-Centre.

Save as aforesaid, no portion of the Permanent Reserve Fund shall be alienated without the consent of the Corporate Members, to be obtained by a postal vote, on which vote the majority shall be not less than three-fourths of the effective votes received.

The Council shall have the power to make from time to time such additions as they consider desirable to the Permanent Reserve Fund from the general funds of the Institution and the provisions of the Bye-laws shall apply to these additions exactly as if they had formed part of the receipts required by the Bye-laws to be invested for forming that Fund.

78. All the securities and moneys forming the assets of the Institution shall be lodged with the Institution's Bankers in the name of the Institution. Any surplus funds not required for the current expenditure and not carried by the Council to the Permanent Reserve Fund shall be invested from time to time by the Bankers, as instructed by the Council, in any one or more the securities appearing in the List of Securities

appended to the Bye-laws as a Temporary Reserve Fund; and no securities forming part of this Fund shall be sold or otherwise disposed of except by order of the Council.

Proposed revised Bye-laws 77 and 78

'77. All compounding fees, received from Members and Associate Members and all admission fees shall be regularly invested as soon as possible after the receipt thereof in short-term deposits or in fixed deposits with the State Bank of India or with one or more Scheduled Banks as defined in Bye-law 59 or in one or more securities appearing in the List of Securities hereinafter referred to as approved Securities appended to the Bye-laws, and only the interest accruing therefrom shall be available for the general expenditure of the Institution. Such moneys and investments shall form the Permanent Reserve Fund. The short term deposit accounts and the fixed deposit accounts shall be operated by the Controller of Accounts and the Secretary or a member of the Finance Committee. The Council shall be at liberty:

(a) To vary the investments at their discretion either in fixed deposit or in short-term deposit with the State Bank of India or with one or more Scheduled Banks as defined in Bye-law 59 or in approved securities;

(b) To deposit all or any of the securities representing the Permanent Reserve Fund with the Bankers of the Institution to secure an overdraft on current account not exceeding Rs. 50,000 at any time; and

(c) To spend any portion of the Permanent Reserve Fund in purchasing land, buildings, furniture and equipment for the Institution or any Local Centre or Sub-Centre.

Save as aforesaid, no portion of the Permanent Reserve Fund shall be alienated without the consent of the Corporate Members, to be obtained by a postal vote, on which vote the majority shall be not less than three-fourths of the effective votes received.

The Council shall have the power to make from time to time such additions as they consider desirable to the Permanent Reserve Fund from the general funds of the Institution and the provisions of the Bye-laws shall apply to these additions exactly as if they had formed part of the receipts required by the Bye-laws to be invested for forming that fund.

78. All the securities and moneys forming the assets of the Institution shall be lodged with the Institution's Bankers in the name of the Institution. Any surplus funds not required for the current expenditure and not carried by the Council to the Permanent Reserve Fund shall be invested from time to time in short-term deposits or in fixed deposits with the State Bank of India or with one or more Scheduled Banks as defined in Bye-law 59; or in one or more securities appearing in the List of Securities appended to the Bye-laws as a Temporary Reserve Fund; and no securities forming part of this Fund shall be sold or otherwise disposed of except by order of the Council. The short term deposit accounts and the fixed deposit accounts shall be operated by the Controller of Accounts and the Secretary or a member of the Finance Committee.'

He then proposed that the revised Bye-laws be adopted. Brig. M. K. Rao (*M.*) seconded the proposal. It was then carried unanimously.

The President declared the Meeting closed at 6.15 p.m.

FORTY-SIXTH ANNUAL GENERAL MEETING
PATNA, JANUARY 30 — FEBRUARY 6, 1966

CHANGES AND ADDITIONAL INFORMATION

The dates of the Forty-Sixth Annual Convention have had to be revised because of circumstances beyond control from January 29-February 5, 1966, to January 30-February 6, 1966. Certain further alterations in the programme have become necessary subsequent to the printing of the approved programme, the details of which are contained in this issue of the *Bulletin*. **Members are requested to note that the Convention Programme given below supersedes that printed on pages (ii) to (vi) of this *Bulletin* and read the details of the complete programme in this changed context.**

In view of these changes it may not be possible for delegates to return the Acceptance Forms duly filled in on December 31, 1965, as indicated in these printed pages. The Bihar Centre is being requested to accept the Acceptance Forms up to January 10, 1966.

CONVENTION PROGRAMME (REVISED)

Sunday, January 30, 1966

8.30 a.m. to 1.00 p.m. 2.00 p.m. to 4.00 p.m.	Registration of local* and outstation members and visitors attending the Seminar on 'The Role of the Engineer to the Fourth Five Year Plan', at the Bihar Centre, Hardinge Road, Patna
9.30 a.m.	Meeting of the Indian National Committee for the World Power Conference at the Bihar Centre
10.00 a.m. to 10.30 a.m.	Adjourned Meeting of the 1965-66 Council at the Bihar Centre
11.00 a.m. to 12.00 noon	Business Session of the 46th Annual General Meeting at the Bihar Centre, and a Meeting of Corporate Members for the formation of 'The Benevolent Fund of the Institution of Engineers (India)'
12.00 noon to 12.15 p.m.	Tea
12.15 p.m. to 1.00 p.m.	First Session of the Seminar at the Bihar Centre

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***Local members (from Patna) are requested to get themselves registered at the Bihar Centre, Hardinge Road, Patna, by January 24, 1966, the latest. Registration of local members may not be accepted after this date.**

1.00 p.m. to 2.00 p.m.	Lunch
2.30 p.m. to 5.00 p.m.	Inauguration of the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan' by Shri Ashoka Mehta, Deputy Chairman, Planning Commission, Government of India, at Bharatiya Nritya Kala Mandir Second Session of the Seminar at Bharatiya Nritya Kala Mandir
5.30 p.m.	A Talk on 'Bio-Engineering' by Shri J. G. Bodhe (*M.*), Member of the Council, at the Bihar Centre

Monday, January 31, 1966

9.00 a.m. to 1.00 p.m.	Registration of local and outstation members and visitors (continued) at the Bihar Centre
9.30 a.m. to 10.30 a.m.	The Ninth Sir Mokshagundam Visvesvaraya Lecture by Dr. T. Sen, Past-President, at Bharatiya Nritya Kala Mandir. Dr. K. L. Rao, Minister for Irrigation and Power, Government of India, will preside.
10.30 a.m. to 10.45 a.m.	Coffee
11.00 a.m. to 1.00 p.m.	Inauguration of the 46th Annual General Meeting at Bharatiya Nritya Kala Mandir by Shri Y. B. Chavan, Union Minister for Defence
1.00 p.m. to 2.00 p.m.	Lunch
2.00 p.m. to 4.00 p.m.	Registration of local and outstation members and visitors (continued) at Bihar College of Engineering
2.30 p.m. to 4.30 p.m.	Third Session of the Seminar at Bharatiya Nritya Kala Mandir
4.30 p.m. to 5.00 p.m.	'At Home'
6.00 p.m. to 8.00 p.m.	Variety Entertainment in aid of National Defence Fund at Bharatiya Nritya Kala Mandir

Tuesday, February 1, 1966

9.00 a.m. to 12.00 noon	Fourth and Final Session of the Seminar at Bihar College of Engineering

12.00 noon to 1.00 p.m.	Addresses by Division/Group Chairmen and Paper Meetings in Public Health Engineering Division; Mechanical Engineering Division; Industrial Engineering Group; Aeronautical Engineering Group; Chemical Engineering Division; Electronics and Telecommunication Engineering Division; and Automatic Control Group at Bihar College of Engineering Addresses by Chairmen* of Civil Engineering Division ; Prestressed Concrete Group; Shell Structures Group; Roads and Road Transportation Group; and Railway Engineering Group at Bihar College of Engineering Seminar (to be continued as necessary) at Bihar College of Engineering
1.00 p.m. to 2.00 p.m.	Lunch
2.30 p.m. to 4.00 p.m.	Paper Meetings in the above Divisions and Groups (to be continued as necessary) at Bihar College of Engineering Seminar (to be continued as necessary) at Bihar College of Engineering
4.45 p.m.	'At Home'
4.30 p.m. to 6.30 p.m.	Students' Session—(1) General, and (2) Technical† at Bihar College of Engineering Visit to Rajgir by special train or special bus (for delegates not participating in Outstation Tours). Bath in Sulphur Springs at 7.30 p.m. Dinner at 8.30 p.m. and rest in train or Rest House
7.00 p.m. to 9.00 p.m.	Variety Entertainment in aid of National Defence Fund at Bharatiya Nritya Kala Mandir

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*Pursuant to the decision of the Third Meeting of the Civil Engineering Division Board held on December 4, 1965, regarding the procedure for holding Paper Meetings in the Civil Engineering Division and the associated Groups, *viz.*, (i) Prestressed Concrete, (ii) Shell Structures, (iii) Roads and Road Transportation, and (iv) Railway Engineering Groups, the re-arrangement as suggested by the Board are also included in this revised schedule. The Chairman of the Civil Engineering Division will decide in consultation with the Chairmen of the various associated Groups, the sequence of papers to be taken up for discussion under the Groups.

†Students desirous of presenting papers at this Session should send their manuscripts to the Headquarters Office at Calcutta not later than Friday, December 31, 1965.

Wednesday, February 2, 1966

6.30 a.m.	Leave Rajgir for Nalanda (visit to last for about two hours). Leave for Patna by special train or bus
11.00 a.m. to 1.00 p.m.	Addresses by Division/Group Chairmen and Paper Meetings in Mining and Metallurgy Division ; Petroleum Engineering Group; Electrical Engineering Division; Nuclear Engineering Group; and Marine Engineering and Shipbuilding Group at Bihar College of Engineering
	Paper Meetings in the Civil Engineering Division and associated Groups (to be continued as necessary) at Bihar College of Engineering
1.00 p.m. to 2.00 p.m.	Lunch
2.00 p.m. to 4.30 p.m.	Paper Meetings in the above Divisions and Groups (to be continued as necessary) at Bihar College of Engineering
4.30 p.m. to 5.00 p.m.	'At Home'

Thursday, February 3, 1966

9.00 a.m. to 9.30 a.m.	Meetings of Panels for Study of Engineering Subjects of Common Interest at Bihar College of Engineering
9.30 a.m. to 10.00 a.m.	Meetings of the Division Boards at Bihar College of Engineering
10.00 a.m. to 10.30 a.m.	Meeting of the Engineering Education and Research Committee at Bihar College of Engineering
9.00 a.m. to 12.00 noon	Paper Meetings (to be continued as necessary) at Bihar College of Engineering
	Seminar (to be continued as necessary) at Bihar College of Engineering
12.00 noon to 1.00 p.m.	Closing Session of the 46th Annual General Meeting at Bihar College of Engineering
1.00 p.m. to 2.00 p.m.	Lunch
2.30 p.m. to 3.30 p.m.	Meeting of the 1966-67 Council at Bihar College of Engineering

3.30 p.m. to 5.00 p.m.	Local Visits for delegates participating in Outstation Tours
7.00 p.m. to 10.00 p.m.	Commencement of Outstation Tours
Friday, February 4, 1966	
9.00 a.m. to 1.00 p.m.	Local Visits for delegates not participating in Outstation Tours
Saturday, February 5, 1966	Outstation Tours in progress
Sunday, February 6, 1966	Conclusion of Outstation Tours and dispersal

PROGRAMME OF INAUGURAL SESSION OF THE CONVENTION TO BE HELD AT PATNA, ON MONDAY, JANUARY 31, 1966

The itemized details of the Inaugural Session of the Convention to be held on Monday, January 31, 1966, are given below.

(1) 11.00 a.m. The Chief Guest, Shri Y. B. Chavan, arrives.

Introduction of the Chief Guest to the President-Elect, Shri B. P. Kapadia, and the Council, by the retiring President, Prof. N. S. Govinda Rao.

(2) 11.10 a.m. Group photograph of the Council with the Chief Guest.

(3) 11.20 a.m. Welcome Address by the Chairman of the Reception Committee.

(4) 11.25 a.m. Announcement of Prizes by the retiring President, Prof. N. S. Govinda Rao, and their award by the Chief Guest.

(5) 11.30 a.m. Conferment of Honorary Life Memberships.

(6) 11.40 a.m. Introduction of the President-Elect, Shri B. P. Kapadia, by the retiring President, Prof. N. S. Govinda Rao.

(7) 11.45 a.m. Presidential Address by Shri B. P. Kapadia.

(8) 12.20 p.m. Inaugural Address by the Chief Guest.

(9) 12.55 p.m. Vote of thanks by the Chairman of the Bihar Centre.

PAPER MEETING

Nuclear Engineering Group

'Some Design Considerations of Dual-Purpose Nuclear Desalination Plant' by S. K. Biswas (*Associate Member*)

'Introduction to the Problems of Magnetohydrodynamic Generation of Power' by S. K. Biswas (*Associate Member*)

Summaries of Papers Published in the Journal vol. 46, no. 4, pt. EL 2, December 1965

ELECTRICAL ENGINEERING DIVISION

Power Demand in Punjab Region and the Measures to Meet It

A. D. Kokane

Associate Member

This paper analyzes the growth of demand for electric power in Punjab region till the end of the Fourth Five Year Plan period and describes the measures which should be undertaken immediately to successfully meet the demand.

Tensor Solution for D.C. Generator Short-Circuit

R. K. Merwade

Non-member

Due to the works of Kron, a unified approach for the solution of the apparently diverse problems of electrical machinery by tensor method is available. Based on this approach, this paper presents the short-circuit calculations for a D.C. generator.

Transient Performance of a Saturated Synchronous Machine under Unbalanced Load and Fault Conditions—1 : Derivation of Equivalent Circuits

P. K. Mukherjee

Non-member

This paper, with a view to analyze the transients, attempts to derive the equivalent circuits of a saturated synchronous machine on sudden application of different types of unbalanced loads and faults which accidentally or otherwise occur in practice. Firstly, the transient equivalent circuits for infinite time harmonics have been developed for the symmetrical sinusoidal components of currents and voltages, neglecting the free transients or the armature transients and assuming the saturation to introduce non-linearity only in the direct-axis zero frequency part of the circuit. Then the equivalent circuits are simplified assuming that the rate of variation of the amplitudes of currents and voltages during the transients is small compared with their frequency variation.

Stability of Synchronous Machines

P. Mukhopadhyay

Non-member

This paper describes an attempt to test the stability of a synchronous machine connected with an infinite bus bar. Based on the small displacement theory, it derives a relationship connecting the torque and power angle; and the stability of a synchronous machine is tested by Routh's criteria. It shows that with negligible armature resistance, the machine tends to be stable. When, however, the output is zero and no damper winding is present, there is a tendency of sustained oscillation even without the armature resistance. When the armature resistance is included, the machine tends to be unstable at low loads and self-excited oscillation due to a small disturbance increases in magnitude.

Outage Detector

Prof. S. V. N. Sarma

Non-member

The network of electric lines is becoming increasingly complex as the pace of electrification in the country is intensified. The efficiency of an electric line is largely determined by the ability for rapid detection of the location of an outage and earliest recovery of the electric supply. This paper describes the working principles of an automatic outage detector which not only reports an outage but also indicates its location in the supply network, and recommends its immediate application in the electric supply networks in India.

Single-Phasing of Three-Phase Induction Motors

T. V. Sreenivasan

Associate Member

One of the major causes of 'burn out' of three-phase squirrel cage induction motors is 'single-phasing', during which the motor runs, drawing power from two lines only as the third line remains open-circuited .This paper investigates the performance of induction motors under single-phasing condition and suggests analytical and graphical methods for the determination of their performance. A simple device, based partially on the principles of a negative sequence relay, is suggested for protection against single-phasing and some experimental results are also presented.

Loading of Transmission Lines

O. Thimmaiah

Member

and

K. C. Krishnaiah

Associate Member

The loading of a transmission line is the most important consideration in the design of an electric supply network. This paper analyzes the loading of an electric transmission line under the different working conditions, and derives the permissible loading curve for transmission lines.

Restriking and Overvoltages During Interruption of Short-Circuits, Unloaded Transformers and Lines

Dr. B. Thoren

Non-member

This paper analyzes the recovery and restriking voltages after interruption of a short-circuit and of possible overvoltages during the interruption of unloaded transformers and lines. The overvoltages during the energization of lines are described and the criteria for the selection of circuit-breakers discussed.

INSTITUTION NOTICES

Application forms for Sections A and B of the Associate Membership Examination to be held in May 1966

Application forms for Sections A and B of the Associate Membership Examination to be held in May 1966, are attached to this issue of the Bulletin. The programme of the Examinations and the detailed instructions are also attached with the application forms and they may be detached for reference, if so desired. Students are notified that no further application forms will be distributed to them.

Applications complete in all respects and accompanied by the examination fee for admission to the May 1966 examinations and one copy of passport size photograph pasted in the space provided on the application form should reach the Head Office before **4.00 p.m. on Tuesday, March 15, 1966.**

Sections A and B of the Associate Membership Examination— Limitations to number of candidates at examination centres

The Examinations Committee have decided that the number of candidates appearing at any examination centre should be restricted to 750 only, in view of the difficulties experienced in making arrangements.

Candidates intending to appear in the examinations should mention in the examination application form the name of three examination centres in order of preference, and the Controller of Examinations will allot each candidate the centre at which he will be permitted to appear. Candidates who fail to mention more than one examination centre will be allotted any centre of examination at the discretion of the Controller of Examinations. No individual representations will be considered after the allotment of the examination centre is made.

Despatch of Admission Cards and Results of Examinations

Students are informed that Admission Cards and Results of examinations will be sent only to their addresses as registered by them in the Institution Head Office at Calcutta.

Rechecking and retotalling of marks

Candidates wishing to have their answer-books rechecked and retotalled must apply to the Controller of Examinations by name, enclosing a postal order for the fee to be paid for this purpose, along with the application. This will facilitate rechecking of answer-books. Remittance of money in any other form or without enclosing the postal order with the application, or applications to the Controller of Examinations not addressed by name, may result in unnecessary delay.

Transferring of Exemption obtained in the Old Scheme of examinations to the New Scheme of examinations

The Examinations Committee has decided that the examinations under the Old Scheme will not be held any further. It has also decided that the exemptions obtained by candidates in Sections A and B under the Old Scheme of Examinations can be transferred to the New Scheme of Examinations in the appropriate subjects.

The Committee has recommended that exemptions enjoyed in the subjects of the Old Scheme be transferred to the corresponding subjects in the New Scheme as given below. The decision of the Examinations Committee is final in this regard, and no further correspondence will be entertained.

Candidates who have secured exemptions in subjects of the Old Scheme of Examinations held upto and including the November 1965 Examinations, and desiring to appear in the May 1966 Examinations, may fill in the appropriate name of the subject in the exemption column after consulting this list.

Section A of the Associate Membership Examination

Exemption obtained in subjects of the Old Scheme	Corresponding subjects in the New Scheme to which exemption is to be transferred
Mathematics I	Mathematics I
Mathematics II	Mathematics II
Applied Mechanics	Applied Mechanics
Principles and Applications of Heat, Light and Sound	Heat, Light and Sound
Principles and Applications of Electricity	Principles and Applications of Electricity
Theory of Structures and Strength of Materials	Strength of Materials
Theory of Machines	Elementary Surveying
Elementary Electrical Engineering	Elementary Surveying
Applied Chemistry	Elementary Surveying
Physical Chemistry and Organic or Inorganic Chemistry	Elementary Surveying

Section B of the Associate Membership Examination

Exemption obtained in subjects of the Old Scheme	Corresponding subjects in the New Scheme to which exemption is to be transferred
Civil Group	
Engineering Materials	Materials and Construction
Engineering Drawing I (Structural Steel or Reinforced Concrete)	Structural Engineering
Engineering Drawing II (Structural Steel or Reinforced Concrete)	Civil Engineering Design and Drawing
Theory and Design of Structures	Theory and Design of Structures
Geodesy	Surveying and Geodesy
Building Construction	Architecture
Geology	Geology
Soil Mechanics and Foundation Engineering	Soil Mechanics and Foundation Engineering
Hydraulics and Hydraulic Machinery	Hydraulics
Roads	Highway Engineering
Town Planning	Town Planning
Railways	Railways
Harbours and Docks	Harbours and Docks
Irrigation	Irrigation Engineering
Water Supply and Sanitary Engineering	Public Health Engineering
Hydro-Electricity	Water Power Engineering
Agricultural Engineering	Agricultural Engineering
Mechanical Group	
Engineering Materials	Mechanical Engineering Materials
Engineering Drawing I (Machines)	General Electrical Engineering
Engineering Drawing II (Machines)	Mechanical Engineering Design and Drawing
Machine Design	Theory of Machines
Workshop Technology	Workshop Technology
Metallurgy	Metallurgy of Iron and Steel
Metrology and Machine Tools	Production Technology
Industrial Engineering & Management	Industrial Organisation and Management
Hydralics and Hydraulic Machinery	Hydraulics and Hydraulic Machinery
Aeronautics	Aerodynamics
Refrigeration and Air-Conditioning	Refrigeration
Thermodynamics and Heat Engines	Thermodynamics and Heat Engines
Electrical Machinery	Utilization of Electric Power
Electrical Group	
Engineering Materials	Electrical Engineering Materials
Engineering Drawing I (Electrical)	General Mechanical Engineering
Engineering Drawing II (Electrical)	Electrical Engineering Design and Drawing

Electrical Engineering General	Utilization of Electric Power
Electricity Supply	Generation, Transmission and Distribution of Electric Power
Electrical Machinery	Theory and Performance of Electric Machines
Radio Communication	Radio Communication
Hydro-Electricity	Hydro Power Engineering
Hydraulics and Hydraulic Machnery	Hydraulics and Hydraulic Machinery
Thermodynamics and Heat Engines	Thermodynamics and Heat Engines
Line Communication	Line Communication
Electrical Measurements	Electrical Measurements
Electrical Installations	Illumination Engineering
Electric Traction	Electric Traction
Ultra High Frequency Technique, etc.	High Frequency Currents
Chemical Group	
Engineering Materials	Chemical Engineering Materials
Engineering Drawing I (Chemical)	General Mechanical Engineering
Engineering Drawing II (Chemical)	Chemical Engineering Design and Drawing
Gas Engineering	Gas Engineering
Engineering Chemistry	Industrial Stoichiometry and Mechanics of Fluid
Thermodynamics and Heat Engines	Thermodynamics
Mechanics of Fluid	Industrial Stoichiometry and Mechanics of Fluid
Size Reduction, Mixing and Separation	Size Reduction, Mixing and Separation
Principles of Heat Transmission, Heat Transfer Equipment and Refrigeration	Principles of Heat Transmission and Furnaces
Diffusional Processes, Evaporation and Distillation	Diffusional Processes, Evaporation and Distillation
Materials and Mechanical Construction of Chemical Plants	Materials and Mechanical Construction of Chemical Plants
Fuels and Combustion	Fuels and Combustion
Principles of Heat Transmission and Furnaces	Principles of Heat Transmission and Furnaces
Chemical Works Organisation and Management	Chemical Works Organisation and Management

Draft Indian Standards

The following draft Indian Standards have been issued recently.

1. Draft Indian Standard Specification for Putty for Use on Wooden Frames (Revision of I.S. : 419-1953).

This standard prescribes the requirements and the methods of sampling and test for putty for use on wooden frames.

2. Draft Indian Standard Specification for Putty for Use on Metal Frames (Revision of I.S. : 420-1953).

This standard prescribes the requirements and the methods of sampling and test for study for putty for use on metal frames.

Members may send their comments on these draft standards before January 10, 1966, to Prof. D. K. Dutt (*A.M.*), Chemical Engineering Department, College of Engineering and Technology, Jadavpur University, Calcutta 32, who is the Institution representative on the Sectional Committee dealing with these draft standards.

3. Draft Indian Standard Methods for the Determination of Reactivity of Coke—Doc : CDC 14 (2748).

This draft standard prescribes the methods of test for critical air blast (CAB) and for thermal value of volatile matter.

4. Draft Indian Standard specifications for (i) Combustion Boats—Doc : CDC 27 (2662), and (ii) Combustion Tubes—Doc : CDC 27 (2663).

This standard prescribes the requirements and the methods of sampling and test for combustion boats and tubes.

Members may send their comments on these draft standards to Dr. V. M. Dokras (*M*), Director of Technical Education, Madhya Pradesh, Bhopal, who is the Institution representative on the Sectional Committee dealing with these draft standards.

5. Draft Amendment No. 1 to I.S. : 1730-1961 Dimensions for Steel Plate, Sheet and Strip for Structural and General Engineering Purposes—Doc : SMDC 6 (707).

Members may send their comments on this standard before January 20, 1966, to Shri J. G. Bodhe (*M.*), Consulting Engineer, 24/28 Dalal Street, Fort, Bombay 1, who is the Institution representative on the Sectional Committee dealing with this standard and a copy to Shri K. K. Nambiar (*M.*), Chairman, Civil Engineering Division, c/o The Concrete Association of India, Cement House, 121 Queen's Road, Bombay 1.

6. Draft Indian Standard Specification for Lead and Scarlet Chromes—Doc : 8 (2919).

This standard prescribes the requirements and the methods of sampling and test for lead chromes, and scarlet (molybdated) chrome used as a paint pigment.

Members may send their comments on this standard to Prof. D. K. Dutt (*A.M.*), Chemical Engineering Department, College of Engineering and Technology, Jadavpur University, Calcutta 32, who is the Institution representative on the Sectional Committee dealing with this draft standard.

Copies of the draft Indian Standards can be obtained from the office of the Indian Standards Institution, 9 Bahadur Shah Zafar Marg, New Delhi; or from its branch offices at 232 Dr. Dadabhoy Naoroji Road, Bombay 1; 11 Sooterkin Street, 3rd Floor, Calcutta 13; 2/12 First Line Beach, Madras; or 14/69 Civil Lines, Kanpur.

Post-Graduate Refresher Courses and Short-term Specialist Courses in Engineering University of Roorkee, Roorkee

The University of Roorkee, Roorkee, will conduct a series of refreshment courses for post-graduates and specialist courses in engineering as shown in the following schedule.

Refresher Courses

Civil Engineering (Irrigation)	April 12 to July 11, 1966
Electrical Engineering	June 1 to August 31, 1966

Specialist Courses

Design of Industrial Structures	April 11 to May 27, 1966
Heavy Earth Moving Machinery	February 1 to February 28, 1966
Tunnels and Underground Excavation	May 30 to June 18, 1966
Prestressed Concrete	January 3 to March 2, 1966
Welding Technology	January 10 to January 31, 1966
Electric Power Transmission	February 1 to February 28, 1966
Steel Foundry Practice	April 6 to April 27, 1966
Erection, Commissioning and Maintenance of Hydro-Electric Power and Steam Stations	April 12 to May 7, 1966
Production Control and Management	May 1 to May 31, 1966
Air conditioning and Refrigeration	July 1 to July 29, 1966
Foundation Engineering	July 12 to August 30, 1966
System Protection	August 2 to August 31, 1966

Further particulars can be obtained from the Director, Refresher Courses, University of Roorkee, Roorkee, Uttar Pradesh.

INSTITUTION NEWS

Technical Information Centre for Chemical Industry

The Technical Information Centre for Chemical Industry, jointly sponsored by the Council of Scientific and Industrial Research and the Indian Chemical Manufacturers' Association, has been started recently. This Centre will cater the chemical and allied industries by way of regular visits to the industrial units, identifying their problems through detailed discussions with the industrialists and their technical staff, solving them by the scientists and technologists at the various National Laboratories, compilation of statistical data pertaining to import, export, indegenous production, installed capacity, number of units in operation, etc., for different chemicals and chemical products as well as preparation of indexes and abstracts of valuable articles and news items from various scientific and technological periodicals concerned with chemical industry.

Members may contact the Scientist-in-Charge of the Centre at 7 Bruce Street (2nd Floor), Fort, Bombay 1 (BR), in connection with their technical problems.

Award of Palmer Prize

The Institution of Civil Engineers have award a Palmer Prize to Shri H. P. Oza (*M.*) and Mr. H. D. Taylor (Non-member) for their paper entitled 'Design and Construction of the Dock Entrance at Bhavnagar Port, Gujarat State, India'. Shri Oza is Director, Engineering Research Institute, Baroda.

Draft Indian Standard Specification for Tool and Die Steel for Hot Work—Doc: SMDC 19(681).

This standard covers the requirements for tool and die steels in the form of bars, blanks, forging rings, and other shapes for hot working applications.

Members may send their comments before February 20, 1966, Dr. D. P. Chatterjee, (*M.*), Chief Metallurgist, Durgapur Steel Project, Durgapur 3, Dist. Burdwan, W. Bengal, who is the Institution representative on the Sectional Committee dealing with this Standard.

Copies of the draft Standards may be obtained from the office of the Indian Standard Institution. Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 1, or from its branch offices 232 Dr. Dadabhoy Naoroji Road, Bombay 1; 11 Sooterkin Street, 3rd Floor, Calcutta 13; 14/69, Civil Lines, Kanpur; or 1/12 First Line Beach, Madras 1.

FORTHCOMING CONFERENCES

Symposium on 'Collaboration Between the Countries of Africa and Asia for the Promotion and Utilization of Science and Technology', New Delhi, February 20-28, 1966

A Symposium on 'Collaboration between the Countries of Africa and Asia for the Promotion and Utilization of Science and Technology' will be held in New Delhi from

February 20 to 28, 1965. Sponsored by the C.S.I.R., the following aspects will be discussed at the Symposium.

Section A ; Problems of Promotion of Science and Technology

- A1 National Science Policy: Planning, organization and financing of scientific research; Order of priority in scientific development, Coordination of scientific activities, Integration of science with the needs of the country.
- A2 Communication of scientific information; Utilization of results of research.
- A3 Education and training of scientific and technological personnel.
- A4 History of science: Development of scientific societies; Creation of scientific outlook; Popularization of science.

Section B ; Problems of aid and collaboration for promotion of science and technology

- B1 Systems of aid from international agencies and their critical evaluation; Suggestions for better methods, etc.
- B2 Areas of collaboration between countries of Africa and Asia: (i) Training of scientific personnel, (ii) Equipment and textbooks, (iii) Scientific research: medical, agricultural, engineering, power and atomic energy, basic sciences, and housing, (iv) Natural resources and their exploitation, (v) Public health, and (vi) Exchange of scientific information.

Papers are invited by the Organizing Secretary, Shri A. Rahman, c/o C.S.I.R., Rafi Marg, New Delhi 1, from whom further details can be obtained.

Second Conference on the Teaching of Engineering Design, Scarborough, April 13-16, 1966

The Second Conference on the Teaching of Industrial Design will be held at Scarborough from April 13 to 16, 1966. It is organized by the Enfield College of Technology, the Institution of Engineering Designers, and the Hornsey College of Art. This Conference will consider the following general areas of the subject: the structure of design courses, methods of teaching engineering design courses, methods of teaching engineering design, the responsibilities of schools and industry in the education and training of engineering designers and probable future developments.

Further particulars are obtainable from the Design Conference Secretary, c/o Enfield College of Technology, Queensway, Enfield, Middlesex, England.

21st Meeting of the Conference Internationale des Grands Reseaux Electriques, Paris, June 8-18, 1966

The 21st Meeting of the Conference Internationale des Grands Reseaux Electriques (CIGRE) will be held in Paris from June 8 to 18, 1966. The object of CIGRE is to bring to light and to make any progress in the technique of high voltage networks by bringing into contact every two years electrical engineers from all countries, with particular respect to investigating the most recent progress in (i) the manufacture and maintenance of generating, transforming and switching plant for electric current; (ii) the provision, insulation and maintenance of overhead and underground lines; (iii) the operation, protection and interconnection of networks; and (iv) the special techniques of networks at voltages above 220 kV which continue to develop.

The 1966 meeting will be held in four Sections as follows:

1. Generation, Transforming and Switching of Current.
2. Construction, Insulation and Maintenance of Overhead and Underground Lines.
3. Operation and Interconnection of Networks.
4. Voltage above 220 kV.

Registration forms and further details of the meeting can be obtained from the Secretariat of the Conference at 112 Boulevard Haussmann, Paris.

33rd International Foundry Congress, New Delhi, December 4-9, 1966

The 33rd International Foundry Congress will be held in New Delhi from December 4 to 9, 1966, under the patronage of the Government of India. The Institute of Indian Foundrymen is the host for the Congress. The main theme of the Congress is 'Technological Developments as means to Increase Productivity in Foundry Industry'. Papers based on this theme are invited and should be of high standard containing original work of scientific and technical importance.

Further information can be obtained from R. M. Krishnan, Executive Secretary, Congress Secretariat, National Physical Laboratory, Jamshedpur 7.

BOOK ACKNOWLEDGMENTS

1. **Construction and Maintenance of Sports Facilities.** W. Ehrler. *Asia Publishing House*, Bombay, Rs. 8.50, 1965, 152 pages.

Stress has been laid in this book on sports facilities and athletics which can be practised by the broad masses of people. Sports facilities for sports of a distinct individual character or sports grounds with complicated competition facilities have been neglected. Of the various possibilities of design and construction those have been selected which can be carried out by means of locally available building materials and for the larger part in the form of self-help. The last section shows how the various individual facilities can be combined into a harmonic whole. Emphasis is on the proper function of small and middle size tracts. Hints as to the arrangement of the auditorium complete this section.

2. **Elements of Differential Calculus.** B. S. Fadnis. *Asia Publishing House*, Bombay, Rs. 24, 1965, 296 pages.

The book is intended for students who have undergone an elementary course in calculus and are familiar with the techniques of differentiation and some applications of the derivation to problems of geometry and mechanics.

The following points have been emphasized in detail : (i) the basic ideas of correspondence, sets, sequences, relative magnitude of quantities, limits of sequences, neighbourhood, the 0 and O-notation, (ii) the role of monotonic convergent sequences in creating the edifice of modern analysis. In the chapter on functions of two variables, the student is introduced to the idea of conformal mapping which is generally done in books on functions of complex variables.

3. **Theory of Structures.** S. P. Timoshenko and D. H. Young. *McGraw-Hill Book Co., Inc.*, New York, $ 14.50, 2nd edition, 1965, 629 pages.

The second edition of the book gives a sound understanding of the fundamental principles that underline methods of structural analysis. Both the statically determinate and statically indeterminate systems, confine essentially to truss and frametype structures. The general approach is closely tied to the fundamental prtinciples of mechanics. The scope of this revision is extensive and includes treatment of both plane and space trusses, influence lines, deflection theory. and methods of analysis for arches, frames and suspension bridges.

4. **Problems in Electronics with Solutions.** F. A. Benson. *E. & F. N. Spon Ltd.*, London, 45 s., 4th edition, 1965, 307 pages.

The first part of the fourth edition of this book contains the problems, with answers in brief, and the second, the solutions, where the steps by which the quoted answers were arrived at are given in full detail. An index has been given at the end of the book, as in earlier editions.

5. **A Text Book of Engineering Chemistry.** R. Paul. *Prakash Brothers*, Rs. 8, 2nd edition, 1965, 423 pages.

This second revised edition of the book is meant for diploma students of engineering colleges and polytechnics. The subject matter has been explained in simple language, and adequately illustrated. Charts, tables, question papers and the syllabii of the Punjab and U.P. Board of Technical education have been provided for the guidance of the students.

6. **Borides, Silicides and Phosphides.** B. Aronsson, T. Lundstrom and S. Rundqvist. *Methuen and Co., Ltd.*, London, 25 s.; 1965, 120 pages.

In this monograph have been assembled for the first time information concerning borides, silicides, and phosphides in an easily accessible form. A description of the character and preparation of these compounds and considers the effect of the more common impurities found in them. The intermediate phases of the Me-B, Me-Si, and Me-P systems have been discussed with emphasis on recent work. The chemical and physical properties of borides, silicides and phosphides have been described in the third chapter; and in the fourth chapter their crystal chemistry with a wealth of clarifying figures. The book concludes with comments on more theoretical work.

7. **Digital Instruments.** K. J. Dean. *Chapman and Hall,* London, 25 s., 1965, 181 pages.

The author, in this book, has explained from first principles how digital instruments work. The explanation is self-contained, starting with an outline of information theory and binary-decimal codes, and explaining how transistors can be used to perform logical functions, and to translate these functions into visible outputs. The author has discussed the ways in which an instrument can obtain information, and how the way in which its logical processes are organized effects its accuracy and reliability. Different methods are discussed for measuring voltage based on their merits, and compared, with reference to commercial instruments in current production. The book sets out to satisfy the idea that digital instruments are an increasingly essential aid to accuracy and efficiency because of their utility to the student, the research worker, and the electronics and control industries.

8. **A Text Book of Surveying and Levelling.** Prof. Shahane and Prof. Iyengar. *Allies Book Stall,* Poona, Rs. 8, 1965, 483 pages.

The book is intended to help engineering students of Indian universities. The matter in the book has been presented in simple language so as to be easily understood by the readers. To enhance the utility of the book various illustrative worked-out examples have been added at the end of each chapter which include questions from various university examination papers. The book will be of help not only to engineering students but also to practising engineers and surveyors.

9. **A Text Book of Hydraulic Machinery.** A Shariff and B. D. Narasimhaiah. *Allies Book Stall,* Poona, Rs. 15, 1965, 508 pages.

This book is meant to aid students reading for the degree and diploma examinations in mechanical and civil engineering of Indian universities. The subject matter has been dealt with in lucid language and a variety of problems have been worked out at the end of each chapter to help the students understand the subject matter better. A number of line diagrams and sketches have been included in the book.

PUBLICATIONS RECEIVED

A copy of the publication entitled 'Adhesive Materials'—Their Properties and Usage: Supplements, vol. 1, no. 1, June 1965, published by the Foster Publishing Company' Long Beach, California, has been received. The supplements will be published quarterly and will bring the data contained in new, and revised adhesive material specifications, eliminating, the need for extensive literature surveys, delays in specification procurement and expensive analysis.

OBITUARY

The sympathy of the Institution is extended to the relatives of those whose passing is recorded here.

Mr. T. R. Sneyd-Kynnersley

Mr. Thomas Ralph Sneyd-Kynnersley, O.B.E., M.C., A.C.G.I., M.I.C.E., M.I.Struct.E., M.I.E., died in England on November 1, 1965, at the age of 79. He was President of the Institution for 1943-44.

Born at Penang in 1886, Mr. Sneyd-Kynnersley had his general education at the Rugby School. He obtained his technical education from the Central Technical College passing the Civil and Mechanical Course Diploma of the City & Guilds of London in 1909. He was apprenticed to Sir William Matthews of Coode Son and Matthews, London, from 1909 to 1912, and thereafter from 1912 to the beginning of the First World War, he worked as Assistant Engineer at the Tanjong Paper Docks and Keppel Harbour Graving Dock, Singapore. During the war he was with the Royal Engineers in France and when he left he had the rank of Major after the war.

He arrived in Bombay in 1920 and was posted as Executive Engineer in the Bombay Improvement Trust and became its Chief Engineer in 1927. During this period he was responsible for the construction of large reinforced concrete tenements in Bombay, three of the largest improvement schemes, laying of roads, and complete reorganization of large sewage disposal works in the city.

In 1929 he joined The Concrete Association of India, becoming its Chief Engineer in 1936, and remained at this position till his retirement from India in 1947. During these years he carried out pioneering work in establishing reinforced concrete as an important construction material in the country. It may sound odd to the present generation to hear that concrete and reinforced concrete were almost unknown in those days not only to the lay public but also to the majority of engineers who could think only in terms of thick brick walls in lime mortar and timber or steel beams and trusses. The tremendous progress that concrete and reinforced concrete made during the term of Mr. Sneyd-Kynnersley's stewardship of The

Concrete Association is in itself a tribute to his patient and untiring efforts on its behalf.

In 1946, Mr. Sneyd-Kynnersley acted as a Managing Director of Cement Agencies, Ltd., for a period of six months. He also worked hard and with great persistence to arouse an awareness in the country of the need for extensive road development. He was a very active member of the Indian Roads Congress and of the Indian Roads and Transport Development Association. In 1943, at the instance of the Government of India and on behalf of the latter organization, Mr. Sneyd-Kynnersley undertook two pilot surveys which proved that roads would pay for themselves not only by actual cash returns to the land through which they pass but also by even more valuable indirect returns.

During the years of the Second World War he took a leading part in organization of air raid precautions activities.

After his retirement, Mr. Sneyd-Kynnersley continued to maintain connections with The Concrete Association and with India. Innumerable Indian students will particularly remember him for the help he gave them in placing them at colleges and institutions in England.

He was also President of the Bombay Engineering Congress in 1930, the Rotary Club of Bombay in 1937-38, and the Indian Roads and Transport Association from 1944 to 1947.

At the 443rd Meeting of the Council, the President and the Council, before commencement of the proceedings, stood up and observed one minute's silence in homage to his memory. Condolence messages were also sent to his next-of-kin by the Secretary and the Chairman of the London Committee.

CORRIGENDUM

TO

BULLETIN, VOL, XV, NO. 3, NOVEMBER 1965

Page 1, Annual Report of the Council for 1964-65; 1. Membership, instead of the table

Honorary Members	Honorary Life Members	Members	Associate Members	Companions	Graduates	Students	Affiliates	Subscribers	Total
11	5	1,894	10,037	6	1,836	40,643	10	60	54,502

please read

Honorary Members	Honorary Life Members	Members	Associate Members	Companions	Graduates	Students	Affiliates	Subscribers	Total
8	5	1,891	10,052	5	1,695	41,104	9	62	54,831

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, industrial and other organizations employing engineers. It is hoped that employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

SITUATIONS WANTED

YOUNG MECHANICAL ENGINEER, B.Sc., passed diploma examination in mechanical engineering from Government Polytechnic, Lucknow, in 1965, and appeared in Section B of the Associate Membership examination ; having 7 months experience in C.B. Oil Mills, Hapur, working as Manager, seeks a suitable job in a good concern immediately. (Office ref. E.S. 214)

A BHU TRAINED, M.I.E., Senior Electrical Engineer, having Government Electrical Licence, considerably experienced in cotton, jute, iron and steel and in various other large industries, worked with reputable concerns like G.E.C., A.E.I., D.V.C., Indian Railways, public sector steel works and other similar big industrial organizations with good references seeks suitable position for Planning/Erection/Maintenance work in any industry or other organization. (Office ref. E.S. 215)

Form 362

THE INSTITUTION OF ENGINEERS (INDIA)

8 Gokhale Road, Calcutta 20

May 1966 Examination

General information and instruction to candidates

(Approved by the Examinations Committee, 51st Meeting, Resolution 21, 30th December, 1958)

(Revised by the Examinations Committee, 57th Meeting, Resolution 19, 27th-29th June, 1961, and 58th Meeting, Resolution 10, 13th and 14th October, 1961).

(1) The next Associate Membership (Sections A and B) Examinations will be held from Monday, May 9, 1966 to Monday, May 23, 1966, excluding Sundays, 15 and 22. The application forms for the Associate Membership (Sections A and B) Examinations and the programme of examinations are attached to this *Bulletin*.

(2) **All applications accompanied by examination fees for admission to the May 1966 examinations should reach the Head Office before 4.00 p.m. on Tuesday, March 15, 1966.** Examinations fees once paid are neither refundable nor transferable to a subsequent examination or to any other account. Receipt of examination forms will not be acknowledged by the Head Office, unless accompanied by a self-addressed post-card.

(3) **Examinations fees should be preferably deposited at the State Bank of India in the candidate's locality. Attention of the candidate is specially drawn to item 3 in Form 363 and item 5 in Form 364 in this regard. The instructions for making such payment are given in Card A (attached herewith) and on its reverse. Other modes of payment may be used only if this is not possible. Payment of examination fees by cheque, postal orders or money order will not be accepted.**

Mention the code number as given in the top of the application form in the bank card.

(4) No application for a change of examination centre will be entertained after 4.00 p.m. on Tuesday, March 15, 1966.

(5) Students who are in arrears of subscription will not be admitted to the examinations.

(6) **The Institution reserves the right to reject incomplete or illegible applications without and reference to the candidate.**

(7) No Student will be permitted to appear in the Section B examination unless he has fully passed the Section A examination or secured exemption therefrom. A candidate for the Section B examination should therefore mention the year in which he passed the Section A examination.

(8) Students appearing for the Section B examination under the revised rules (17(a) to17(i) of the rules of examinations (see Rules and Syllabuses of Studentship and Associate Membership Examinations) should clearly state in the application form the name of the Local Centre to which they are attached.

(9) A candidate who has already passed the Section A and B examinations or is exempted therefrom will be permitted to appear in any paper or papers of Section A and/or Section B on payment of an examination fee of Rs. 50.00 per paper. The details of passing the Section A and B examinations or of exemption therefrom should be clearly stated in the examination form, with the grade of membership.

A candidate may also appear in one complete branch of engineering on payment of usual examination fee of Rs. 75.00. Rules of examination for such a candidate will be identical with those applicable to regular candidates.

(10) The Design and Drawing papers are of 5½ hours duration, with a one-half hour recess between. Candidates will not, however, be permitted to leave the examination hall.

(11) Candidates are not permitted to use handbook(s) for the paper in 'Design and Drawing' of Section B. They may, however, use steel tables of the Dorman-Long type.

General information and instruction to candidates (*contd.*)

(12) Candidates detected using unfair means in the examination hall will be expelled from the Institution and will not be re-admitted to the Institution at any future time.

(13) Candidates reappearing in subject(s) in which they have already secured exemption(s), will have their paper(s) cancelled. The previous exemption(s) will stand.

(14) It is sometimes found that candidates do not enter their Studentship Number, Roll Number, or other necessary particulars on the answer-books. Such answer-books will be rejected and no attempt will be made to locate the candidates. Candidates should therefore take particular care to write down these particulars on the answer-books correctly.

(15) The results of the May 1966 examinations will be declared before the last day of August 1966.

(16) Candidates will be permitted to apply for the checking of their answer-books as to whether the marks allotted in the answer-books were added correctly and all the answers within the answer-books were appropriately marked, on payment of Rs. 5 as checking fees for each paper. Candidates wishing this check to be made should apply to the Controller of Examinations within 15 days of the date of posting the results by him.

(17 **The marks of each examination will be communicated to candidates along with results free of charge.**

(18) The Institution reserves the right to cancel the results of any candidate without assigning reasons in which case, the marks will not be supplied.

(19) In any future correspondence, in regard to the May 1966 examination, candidates should always mention the Section of the Associate Membership Examination in which they appeared and their centre of examination in May 1966.

THE INSTITUTION OF ENGINEERS (INDIA)

8 Gokhale Road, Calcutta 20

May 1966 Examinations

Programme

Associate Membership Examination—Section A

	S.T. 10.00 to 1.00	S.T. 2.00 to 5.00
Monday, May 9, 1966	Mathematics I	Mathematics II
Tuesday, May 10, 1966	Applied Mechanics	Principles and Applications of Electricity
Wednesday, May 11, 1966	Heat, Light and Sound	Engineering Drawing
Thursday, May 12, 1966	Strength of Materials	Elementary Surveying

Associate Membership Examination—Section B

Monday, May 9, 1966	Materials and Construction Mechanical Engineering Materials Electrical Engineering Materials Chemical Engineering Materials Principles and Practice of Coal Mining Mineral Dressing Electronics and Telecommunication Materials	Theory and Design of Structures Industrial Organization and Management Theory and Performance of Electric Machines Industrial Stoichiometry and Mechanics of Fluids Principles and Practice of Metal Mining Physical Metallurgy and Physical and Mechanical Testing of Metals
Tuesday, May 10, 1966	Structural Engineering Generation, Transmission and Distribution of Electric Power Diffusional Processes, Evaporation and Distillation Mine Ventilation, Explosions, Fire and Inundation Refractories Applied Electronics and Circuits	Surveying and Geodesy Theory of Machines Electric Traction Fuels and Combustion Mine Surveying Foundry Engineering Transmission Lines and Networks
Wednesday, May 11, 1966	Hydraulics Industrial Engineering Illumination Engineering Elementary Electrical Engineering Mineral Dressing Practice Metallurgical Analysis Advanced Radio and Electronic Engineering	Highway Engineering Fuels and Refractories Radar Engineering and Microwave Techniques Workshop Technology
Thursday, May 12, 1966	Civil Engineering Design and Drawing Mechanical Engineering Design and Drawing Electrical Engineering Design and Drawing Chemical Engineering Design and Drawing Electronics and Telecommunication Design and Drawing	(From 10 a.m. to 1 p.m. and 1.30 p.m. to 4 p.m.)
	Mining Machinery Physics of Metals	Generation, Distribution and Utilization of Power in Mines Metallurgy of Less Common Metals

Programme—(*contd.*)

Friday, May 13, 1966	Geology Production Technology Non-ferrous Metallurgy	Thermodynamics and Heat Engines Size Reduction, Mixing and Separation Telegraphy and Telephony
Saturday, May 14, 1966	Railways General Mechanical Engineering	Hydraulics and Hydraulic Machinery
Monday, May 16, 1966	Irrigation Engineering Refrigeration Line Communication Gas Engineering Mining Geology Industrial Metallurgy Antenna and Wave Propagation	Harbours and Dock Drilling Engineering Television Utilization of Electric Power Principles of Heat Transmission and Furnaces
Tuesday, May 17, 1966	Metallurgy of Iron and Steel Industrial Administration	Water Power Engineering Electrical Measurements Heat Treatment of Metals and Alloys
Wednesday, May 18, 1966	Public Health Engineering Railway Locomotives and Rolling Stock General Electronics Refrigeration and Air-Conditioning Mine Economics Electrometallurgy and Hydrometallurgy Electronic Measurements	Thermal Power Engineering Servomechanisms
Thursday, May 19, 1966	Town Planning Automobile Engineering High Frequency Currents Chemical Works Organization and Management Metallurgy and Assaying Fuels and Furnaces Industrial Electronics	General Electrical Engineering
Friday, May 20, 1966	Architecture Air-Conditioning Radio Communication Materials and Mechanical Construction of Chemical Plants Mine Design and Planning Metallurgical Thermodynamics Radio Communication Systems	Soil Mechanics and Foundation Engineering Aerodynamics Hydro Power Engineering Metallurgy Mine Organization and Management Engineering Metallurgy Audio Frequency Engineering
Saturday, May 21, 1966	Production Technology and Industrial Engineering Principles of Semiconductors and Transistor Circuits	Agricultural Engineering Thermodynamics Carrier Current Engineering
Monday, May 23, 1966	Principles of Line and Radio Communication	

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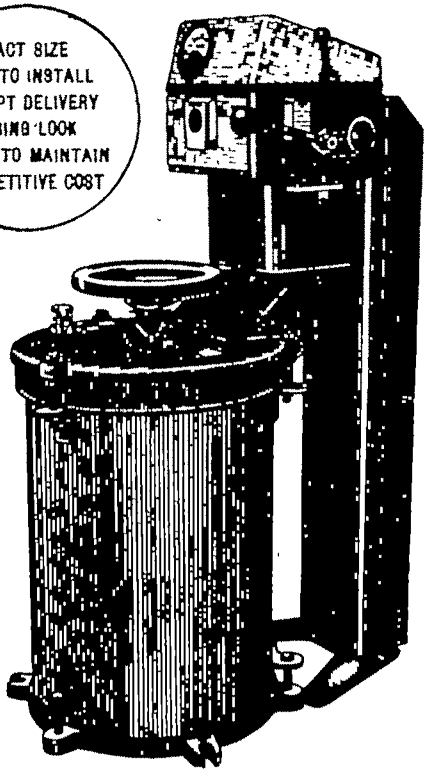

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THE BULLETIN
OF
The Institution of Engineers (India)

DEPUTY SECRETARY & ACTING EDITOR : D. K. Ghosh, B.E., C.E., D.T.R.P., A.M.I.E

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PROCEEDINGS OF THE FORTY-SIXTH ANNUAL CONVENTION, PATNA, JANUARY 30, 1966

The Annual General Meeting

Business Session, Sunday, January 30, 1966

The Forty-Sixth Annual General Meeting was held in the building of the Bihar Centre, Hardinge Road, Patna, on Sunday, January 30, 1966, at 11.00 a.m.

Two hundred and fifty-three Corporate Members attended the Meeting, and, in the absence of the President, Prof. N. S. Govinda Rao, under the most unfortunate circumstance, it was presided over by Shri B. P. Kapadia, President-Elect, as the seniormost member of the Council.

Before commencement of the Proceedings, Shri Kapadia said that the Council at a meeting held that morning had passed the following resolution on the sudden and unfortunate death of the beloved Prime Minister, Shri Lal Bahadur Shastri and recommended it to the General Body of Corporate Members for adoption, which was passed by the members present.

'The Council and the General Body of Corporate Members of the Institution of Engineers (India) record with deep regret the sudden passing away of the beloved Prime Minister, Shri Lal Bahadur Shastri, and send their most sincere sympathies to his wife and members of his family.'

Further resolved that a copy of this resolution be also forwarded to the President of India.

Shri Kapadia then requested the members present to stand and pay their respects to his sacred memory by observing two minutes' silence.

The members present stood in silence for two minutes in memory of the late Prime Minister, Shri Lal Bahadur Shastri.

Shri Kapadia then said that the Council had also earlier that morning passed the following resolution on the sudden and unfortunate death of Dr. H. J. Bhabha, who was an Honorary Life Member of the Institution and a scientist of international fame, and recommended it to the General Body of Corporate Members for adoption, which was passed by the mebbers present.

'The Council and the General Body of Corporate Members of the Institution of Engineers (India) record with deep regret the sudden passing away of Dr. H. J. Bhabha, who was an Honorary Life Member of the Institution and a scientist of international fame, and send their most sincere sympathies to his mother and other members of his family.'

Shri Kapadia then requested the members present to stand and pay their respects to his memory by observing two minutes' silence.

The Members present stood in silence for two minutes in memory of the late Dr. H. J. Bhabha.

1. After welcoming the delegates to the 46th Annual General Meeting, Shri Kapadia introduced Shri D. K. Ghosh (Associate Member)—the newly appointed Deputy Secretary of the Institution. Then, he took up the minutes of the 45th Annual General Meeting, circulated to all members of the Institution in the April 1965 issue of the *Bulletin*, for confirmation.

Shri Kapadia put the minutes to the house. Shri K. C. Banerjee (*Member*) proposed that the minutes be confirmed. Shri S. K. Laha (*Member*) seconded the proposal. It was carried unanimously.

2. Shri Kapadia next took up the Annual Report of the Council, printed in abstract in the November 1965 issue of the *Bulletin*, and the Audited Accounts for the year ended August 31, 1965, and asked if members had any comments to make.

Lt.-Col. R. S. Attre (*Member*) proposed that the Annual Report be adopted and the Audited Accounts be approved. Shri K. C. Banerjee (*Member*) seconded the proposal. It was carried unanimously.

3. Shri Kapadia then asked the Deputy Secretary to read the report of the Council on the elections for the session 1966-67 of the President and the Council. The Deputy Secretary, Shri D. K. Ghosh, read as follows:

(i) Shri B. P. Kapadia had been elected by the Council as President for the session 1966-67. (*Applause*).

(ii) The following members by virtue of their having been elected Chairmen of Local Centres become members of the Council under Bye-law 44:

Andhra Pradesh Centre	... Lt.-Col. R. S. Attre
Assam Centre	... M. R. Sitaram
Bengal Centre	... T. P. Marik
Bihar Centre	... A. S. Srivastava
Bombay Centre	... V. Y. Kamat
Delhi Centre	... Maj.-Gen. R. A. Loomba
Gujarat Centre	... G. S. Desai
Jammu & Kashmir Centre	... (*Vacant*)
Kerala Centre	... T. P. Kuttiammu
Madhya Pradesh Centre	... Dr. V. M. Dokras
Madras Centre	... N. G. Mahalingam
Mysore Centre	... I. M. Magdum
Nagpur Centre	... (*Vacant*)

Orissa Centre ... S. Padhi
Poona Centre ... Col. R. V. Godbole
Punjab Centre ... Kulbir Singh
Rajasthan Centre ... B. D. Satsangi
Uttar Pradesh Centre ... P. S. Bhatnagar

(iii) Dr. S. P. Luthra by virtue of his being elected from the Delhi Centre becomes member of the Council under Bye-law.

4. Shri J. Datt (Member) proposed that Messrs. Price, Waterhouse, Peat & Co. be re-appointed Auditors of the Institution for the year 1965-66 on a remuneration of Rs. 6,000 per annum. This was seconded by Shri S. K. Laha (*Member*). It was carried unanimously.

With a vote of thanks to the Chair, the Meeting terminated at 12.00 noon

Inauguration of Seminar, Sunday January 30, 1966

Welcoming the guests and members present, Dr. T. Sen, Past-President, said:

'You are aware that our President, Prof. N. S. Govinda Rao, has unfortunately fallen ill. It has, therefore, devolved on me to deputise for him, which is not exactly a precedent for this organisation, and you will really be sorry to see me deputise for Prof. N. S. Govinda Rao. However, I am happy to do this duty and I, on my own behalf and on behalf of all the field staff of Engineers, welcome the very popular Chief Minister of the State, Shri K. B. Sahay. We are also fortunate that the Minister for Revenue of Bihar, Shri B. C. Patel, has very kindly agreed to preside over the inaugural meeting, and I am glad that Shri R. L. Singh Yadav, the Minister for Public Works, who is the Chairman of the Reception Committee, has very kindly come here. We are fortunate that they have made it convenient for themselves to come to this function of Engineers.

We are to make a review of the Seminar on the Role of Engineers in the Fourth Five Year Plan and sum up the discussions we had in all the States and the Centre.

The Chief Minister, Mr. Sahay has kindly made it convenient for himself to inaugurate our Seminar and Mr. Patel, Minister for Revenue, has agreed to preside. I, on behalf of all of you and on my own behalf again welcome them to this Seminar.'

Reviewing the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan', Brig. M. K. Rao, Convenor, said:

'We are nearing the completion of fifteen years of Planning covering three Five Year Plans. During the third Five Year Plan, we had been confronted with military conflicts twice on our borders. They have affected the Third Five Year Plan programmes.

The Third Five Year Plan had laid greater emphasis on agriculture than the two previous Plans. The First and Second Five Year Plans have not relegated agriculture to the background but given it sufficient importance. Yet, we find today a steep rise in the prices of all essential commodities, much to the concern of the lower middle class, the middle-class and the salaried people. Housing problem is still very acute in all urban areas. Do we lack proper organisational approach and co-ordination to achieve the targets? Do we have real quantitative assessment or stock taking of the development plans to compare achievements with money spent?

While we leave these questions to be answered by the planners, let us have a look at the Fourth Five Year Plan from the point of view of the engineer.

The final figures of the Fourth Plan are not yet available but the memorandum of Fourth Five Year Plan gives some details. Taking only those fields of engineering activity such as irrigation and power, industry small and organised, transport and communications, Housing and construction, the total outlay in public and private sectors amount to about Rs. 14,970 crores accounting for about 66% of the total outlay of the Plan—which is around Rs. 22,500 crores. During this Plan, if the engineer can play an effective role the savings of even 5% can result in Rs. 748.5 crores. This modest savings can certainly be doubled, in my opinion, if the engineers take up the challenge and throw up the right leadership.

The problems of engineering are precise and specific. No doubt, delays and lack of coordination and similar problems are present in some measure or other in any economy trying to build up from scratch. The problems can however be pin-pointed and so dealt with certainly by engineers.

It may be interesting to all of us to note that according to Shri O. K. Ghosh, our per capita income today is estimated to be about Rs. 360. Assuming that a rate of Rs. 12 per annum is expected to be achieved, if all our Plans are successful, the per capita income, based on 1952-53 prices may be, in nine year's time (1975), equal to that of Iraq and perhaps we may be just about reaching the level of Egypt of today. And in 34 years (2000 A.D.) the per capita income may be equal to that of Bulgaria of today and in 84 years (middle of 21 Century) it may be equal to that of France of today. Certainly, Egypt, Bulgaria, France and other countries are not going to mark time for us to catch up. Therefore, if we have to have any reasonable per capita income comparable to the rest of the world, we have to reach the point of take-off soon. Who else can increase this per capita income rapidly and contribute for the national income so that India can be counted as a strong force by 2000 A.D.? Yes, it must be the engineer. Engineer is the builder of the Nation. Who can deny his birth-right? The engineer must occupy it no matter what others think or debate.

The Institution of Engineers (India), under the brilliant leadership of Professor N. S. Govinda Rao, the retiring President, rightly appreciated the need of the hour and had conceived of this Seminar. I am confident that we, the members of this premier Institution, shall contribute our share to meet the challenges at this critical period of our Nation's history. We have received about 80 papers from Engineers from all walks of life. I am sure, we would have got many more thought provoking articles, had it not been for the fact that the engineers today spend most of their valuable time explaining technical appreciations and preparing briefs to non-technical administrators placed over their heads!

I shall now give a brief review of the type of questions we are going to debate and answer in the Seminar.

Defence orientation

Have we coordinated the Defence requirements to the indigenous industry, both in public and private sectors, in order to effect a smooth and quick change-over to meet the sudden emergency expansions?

Have we planned our road and rail communications and tele-communication net works after fully considering the possible traffic patterns in war-time conditions?

Agriculture

Have we given sufficient thought for production of pesticides and cheap and effective grain storage containers?

Have we kept the design of mechanical agricultural implements to suit local Indian conditions?

Are we manufacturing electric motors and pump sets within easy reach of the farmers?

Have we tapped the sub-soil waters in arid zones?

Can we use sprinkler methods of irrigation where the water supply is limited?

Can we use windmills in lifting water or charging batteries, where electricity does not reach to remote corners?

How can we reclaim waste, desert and usar lands and arrest the soil erosion?

Can we utilise economically the available water, cutting down waste due to evaporation, seepage and other losses?

Can we utilise the sewage waste?

Can we adopt underground equivalizers by underground drains and shallow wells?

Indigenous resources

Can we make the maximum utilisation of the indigenous materials, machines and men?

What is wrong if we replace copper conductors in transmission lines by basic aluminium conductors? Can't we replace by aluminium in the windings of electric motors as copper has to be imported, whereas aluminium is available locally? Why can't we use aluminised steel instead of stainless steel; aluminium alloy of suitable mechanical strength instead of brass. for fasteners, terminals, lowload loops, register frames?

Can't we utilise the maximum talent from Consultancy Boards, Consultancy Services and Advisory Bodies?

It is stated that a good portion of 70 to 80% of the country's requirement both in the matter of technical know-how and of designing and engineering, can be met indigenously. Can't we draw upon the public and private owned firms for experienced men in the field of planning, designing, installation, fabrication and execution of various industrial plants, replacing foreign collaboration? Can't we have an immediate and phased programme to replace the foreign consultancy?

Can't we create conditions in our country to arrest the drift of first-class scientific and engineering talent from migrating in search of jobs to foreign countries? When Indian talent flourishes well abroad, why doesn't it do so, in the Indian environment?

The import requirements of components and spares during the Fourth Plan are estimated to be about Rs. 1,500 crores. Can't we set up a screening committee to delete components capable of local manufacture and allow vital spares only to be imported? Why can't we make use of the large workshops located with Public concern Corporations and with large private undertakings?

Can't we find substitutes from the Indian manufactured machines to that of recommended foreign machines? The Indian made machines may not be so sophisticated and multipurpose. We may have to do three or more operations against one by imported machines.

Are we not manufacturing our recurring requirements of tools? Why can't we manufacture the tools in the first instance avoiding initial importation?

Waste avoidance

Are we paying proper attention to the imbalance of machinery in different workshops or firms?

If non-availability of raw materials present bottle-necks in production, have we given sufficient thought to 'input and output analysis?'

Can't we reduce the cost of production by using modern techniques such as time and motion study, material control, inventory control, cost and budgeting controls, standardisation, operational research, programme evaluation and review techniques, critical path methods, value engineering?

Standardisation

In the field of standardisation, can't we effect economies in adopting the designs to fall in line with international standards like that in electric motors where re-designing showed considerable savings in raw materials.

Is it possible for us to switch over to 500 kV transmission system as against the present practice of using 220 kV lines? Won't there be any savings in electrical energy transmitted?

To serve remote places under rural electrification, can we effect economy by dispensing away with long distance L.T. 3-phase and single-phase distribution lines by use of small transformers hooked on to the 12 kV lines?

Research and development

Our industrialisation today is at the mercy of foreign design given to us by foreign collaborators. Some of the methods adopted do not suit Indian conditions. Possibly, therefore, we are producing at higher costs, although the Indian skilled labour is cheap. How long do we intend carrying on like this? Are we not to produce our own designs eventually? It may take some time. As an interim measure, will it be better for us to buy the designs only and work out the detail of development and manufacturing processes ourselves?

Shouldn't we lay emphasis on educational orders, developmental and pilot projects?

Are we going to repeat the sad story of the textile industry which entered the research field only after 90 and odd years of its existence? Are we to repeat the story of '60 year old' steel industry to discover that we could not expand the plants ourselves without external help in design and erection?

Are we not to make a study of new techniques, new projects and new materials, provided by the rapid advances elsewhere in the world and adopt them with advantage?

Is there no strong case for us to spend much more than what we are spending on research and development? Will it not yield rich dividends and make us self-reliant, self confident and self-generating?

Can't we immediately pool all our available resources from our research laboratories like those of Council of Scientific and Industrial Research, Central Mechanical Engineering Research Institute, Central Fuel Research Institute, National Coal Development Corporation, Indian Fertilizer Corporation and many other scattered 'development cells' attached to major plants in our country?

It is said that our country could save anything between Rs. 700 to 800 crores in terms of foreign exchange alone during the next 10 years, if indigenous know-how can be developed in the fields of designing, engineering and consultancy works. What shall we engineers do about it?

Export promotion

We are today exporting merchandise valued at Rs. 800 crores a years. It has to be raised to Rs. 1,200 crores a year by the end of Fourth Five Year Plan. It means that we have to double up our industrial output in the next five years. The quality and quantity of engineering goods have to be increased. How can the engineers play a vital role in this field?

Can we resort to importation of certain essential materials required to manufacture some sub-assemblies or parts like water-turbines, switchgears used in the electrical generating plants and export such assemblies to other countries to earn foreign exchange?

Can't we make a concerted drive to export goods from our machine tool industry where a good reputation has already been built up?

Can we utilise the installed machine capacity to run two or even three shifts to promote exports? We may examine exporting of spare parts.

Can't we organise available capacity and available expertise, scattered as it is in various units?

Town planning and House building

Two-thirds of construction outlay of about Rs. 8,000 crores in the Fourth Plan is allotted to building materials. Can't we discard outmoded methods and effect economies by re-designing the structures to save steel and other building materials? Even 5% savings in this field will result in savings of about Rs. 266 crores.

Is coordination lacking in the construction, planning and execution of building projects? Should we invest such a high percentage of project allocations in putting up magnificant or imposing structures or multistoreyed buildings where land is cheap? Can't we cut down the expenditure to provide semi-permanent buildings lasting say 30 years instead of 100 years? How can we achieve speed in construction? The delays, after all, when computed, results in waste and contribute to high costs.

A steady stream of population is migrating from the villages to the cities. Are we paying sufficient attention to the urban development? Can we adopt the star pattern layout so that the industrial, the residential and marketing areas are not too distant from each other, yet at the same time leaving large areas for expansion?

Engineers in teamwork

There are fields of activity where engineers have to work in close cooperation with other specialists such as scientists, metallurgists, soil-chemists, agronomists, geologists, architects, businessmen, administrators. economists and auditors. What kind of additional basic education is needed for the engineer to play an effective role in such circumstances? What kind of training is required at the graduation level and at subsequent service intervals?

Engineers as managers

The engineer, as has been stated, has a very important role to play in the nation building activity of the country. It is an activity which touches almost every other human interest. Should the engineer, therefore, not be given the authority with responsibility? Authority and responsibility must go together—they cannot be separated. Has not the time come for those much needed reforms to be put into practice? How should our Institution put forward the views of engineers before the 'Reforms Commission'.

We are now looking forward to our brother engineers assembled here for giving a serious thought to the problems that face the country and the engineers.

Once again let me repeat, the Aim is for the engineer to play a vital, effective and constructive role for meeting the wants of the people, for the growth of the wealth of the Nation and lastly for the good of the profession of engineering itself.

Inaugurating the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan', the Chief Minister of Bihar, Shri K. B. Sahay, said:

'It gives me great pleasure to be amongst you this afternoon. The subject that you are discussing here is of the utmost importance to the country, faced as it is with grave problems, both internal and external. The importance of engineers and other scientists at this crossroad of our history and our very existence, cannot be over emphasised. We have, in certain respects, very limited resources and we are an economically backward nation. The problem before you is to devise ways to utilise these resources so that the maximum benefit may accrue to the multitudes. No doubt you will be able to find certain solutions and make concrete suggestions which will be welcomed by planners, not only for the Fourth Plan but also for subsequent ones.

2. You are aware that the greatest obstacles to our progress as a nation are backwardness and poverty, which have to be eliminated, or at least greatly reduced before we can be a truly modern nation. With our meagre resources we must set ourselves realistic and achievable targets, targets which are simultaneously sufficiently high to furnish tangible evidence of progress when they are achieved. Unfortunately our already difficult position becomes even more so when we have to meet the defence needs of our country and keep putting aside large portions of the national income to met threats from outside and natural disasters from within. To find ways and means for achieving the maximum from whatever we have, is your task. All this has to be achieved rapidly and economically.

3. As you know, the Fourth Five Year Plan has been greatly restricted due to paucity of resources available for development. Canals, roads, powerhouses, industrial plants, oil refineries, all these are to be developed. At the same time, those already completed have to be fed and the tempo maintained and steadily raised within our limited resources and time. If we are to improve our position among the economically developing nations we have to achieve more than others. In the words of the Red Queen of the 'Alice inWonderland', we have to run faster and faster eve to remain in the same place.

4. We have adopted the policy of economic planning. Two plans have already been completed. The 3rd Five Year Plan as you know will be over soon and the 4th Five Year Plan will be launched. We started with modest investment in our First Five Year Plan but as you are aware the 4th Five Year Plan is expected to have an investment of more than rupees 20 thousand crores. Once we have brought in a dynamism in our economic development, it is not possible for us to slacken our efforts. With an investment of the magnitude of over Rs. 20,000 crores in the 4th Five Year Plan you can imagine what would be the investment of the 5th and 6th Five Year Plans and how much personnel will be required to implement them.

5. Our plans and policies are directed towards the uplifting of living standards of our people which entails material production of various things. Most of the processes are interlinked. We have to produce more and better foodgrains and to achieve this end, we have to provide irrigational facilities,

fertilisers, better agricultural implements, etc. Thus to achieve the end of more food production we have to build dams, establish fertiliser and tractor factories, etc. In the same way for the material conforts of our people, if we want to produce consumer goods, the process not only involves establishment of factories for consumer goods only but also heavy industries which can provide machine and spare parts for the lighter industries. You will, therefore, see that it is the Engineer who is the king pin of our developing economy. Whether it is building a dam, house, or a factory, it is the Engineer who counts. Nearly 80 percent of the personnel required for the implementation of our schemes will be Engineers. A great responsibility is, therefore, placed on their shoulders. If the engineering profession fails to deliver the goods it would not be for any body else to fulfill the loss.

6. It takes a long time of training and experience to make an Engineer. We require people of various skills to keep our factories going. There is, therefore, need to rationalise the engineering personnel and open engineering institutions so that the requisite number of engineering personnel are available for the success of our plans and economic policies. It would not be out of place to mention that in highly developed countries like U. S. A. and Russia the number of people studying science and technology is highest. In our country we have not yet been able to provide sufficient opportunities for those youngmen who want to take engineering as their profession. I am sure this distinguished gathering will discuss as to how it would be possible for us to provide sufficient engineers not only for the 4th Five Year Plan but also for the future plans.

7. Let me refer to the very sad incident which has occurred this month. Our beloved Prime Minister the late Shri Lal Bahadur Shastri died. Only a few months ago he led this country through one of the greatest crises.

Through firmness and dexterity he won the war and was equally determined to win the peace. The Tashkent agreement which he signed paves the way to peace in this subcontinent. I hope our countrymen will follow the ideals of the great departed leader who wanted peaoe and happiness. You Engineers will. I am sure, do your best for bettering the living standard of the people through which only happiness can come to a community. The loss of Dr. Bhabha has also given a great blow to our country. Dr. Bhabha always pulled his weight towards the peaceful uses of atomic energy. The use of the atom for destructive purposes was alien to him. The great ideals of Dr. Bhabha will no doubt be followed by engineers and technologist of our country.

8. I thank you again for giving me the opportunity to inaugurate this conference.

Jai Hind'

Delivering the Presiding Officer's Address, Shri B. C. Patel, Minister for Revenue, Bihar, said:

'I am glad to inform you that I have not come prepared with a written speech and, therefore, after most careful review of the whole thing by the Chief Minister of Bihar I would have been only wasting the valuable time of the conference if I repeat some of the things which he has so ably placed before you. In this distinguished gathering where a galaxy of talents in science and technology has gathered you will pardon me if I do not have the necessary confidence to address you on a subject which is specifically the field of the experts.

There is no denying the fact that in any scheme of development, in any transformation of society from traditionally agricultural society to what Rustak has said mass consuming society, the leading role has to be played by engineers and technologists.

One of the greatest men of the History who not only created a revolution and transformed the country but whose methods are affecting the patient transformation of millions of men of this world—I mean, Lenin—said that 'One expert is equal to 20 Communists'. And another famous saying of his in a very concentrated form or pointed form emphasises the importance of the role of the technical experts in the process of a country's development states that when Lenin was asked to define Communism he said, 'Communism is nothing but Russia plus electricity'.

These two quotations from a person who was admittedly one of the greatest men of the history, emphasises the great role of the Engineers in the modern world.

There was a time when science and technology did not necessarily travel together. We have been used to living in a world where technology is taken for granted where technology and science are inseparable. Perhaps you remember that in the history of scientific development and development of science and technology there was a period and that was a period before Becon and Newton, when technology was divorced from science. This inter-relationship of science and technology places a heavy responsibility on the engineers to play a vital role in the development of economy and in the inter social development of the country. As a matter of fact, not only in the development of our economy but in the entire social development of economy, I cannot conceive of any sector of life—be it health, be it defence, be it culture, be it agriculture, be it industrial—where the role of the engineers has not to play an effective part. What is the need of the hour has been ably emphasised in the Address of the Convener of this Seminar and re-emphasised by our Chief Minister.

All the questions about the development, about the role of engineers, about the study of our economy, about the study of technological education and know-how and even the matter relating to foreign collaboration, which could be raised, have been raised in the paper and it is for this Seminar to answer those questions, which imperatively demand answers and on the answers of which depends success or failure of the Fourth Five Year Plan.

It is no secret to us, particularly to members of this distinguished gallery, that our economy is passing through a most desperate period. The First Five Year Plan was drawn with the hope of buoyancy and the target which the planners put forth was more than achieved.

Then came the Second Five Year Plan and though we were able to get through the plan, there were periods of anxiety, strain and stress. Then came the Third Five Year Plan with serious imbalance in all sectors and not only the growth rate of development has been slowed down but the stability, and particularly the price stability, has been affected adversely much against the worst dream of planners.

I would ask you to point out any passage in the Third Five Year Plan, even though somewhat vaguely, which could refer to the conditions now obtaining in this country.

The Fourth Five Year Plan has added to the desperate condition that is obtaining today and this is the greatest challenge to be met. Those who are responsible for our Five Year Plan are the mightiest tallents of our country. There is no doubt about it. After all, in this fast moving world, one cannot be certain of any calculation. If the calculations can go wrong, it is no criticism of them. Even the calculations of greatest intellects particularly in the economic plan, where vast society has to be changed, have gone wrong in the past and will go wrong in the future. Unlike the drama that we see on the stage, the drama of mankind on the pages of history has never been proverbial and the curtain has never been dropped. The drama goes on and with all our faults, with all our pitfalls, we shall march ahead along success and strength. This march ahead towards the goal is indefinable, it is not definable because if we define that, then it will be the end of all progress. As we go on progressing, our goal goes on proceeding further and further we reach our goal, the goal progresses further. That is the challenge to us and that is the challenge in the world of material development, the greatest challenge to this distinguished gathering, which is the gathering of distinguished engineering talents.

You have raised in the paper one very important point regarding our dependence on foreign collaboration. The country expects answer solely from you as to how far and how long we are to depend on foreign collaboration. Is it not the greatest challenge to engineers and scientists of this country, which can boast at engineers like you and scientists like Dr. C. V. Raman, late Dr. H. J. Bhabha, Dr. J. C. Bose, Dr. Meghnad Saha. A challenge is thrown before you and before the leaders of science of this country as to how long India during the course of that journey of progress will have to remain dependent on foreign collaboration.

We should be grateful to those foreign collaborators who have made our progress possible in the various fields. If we plead for self-reliance, particularly in the engineering field, for the growth of the economy of the country, the answer cannot be given by politicians, the answer can be given by you and you alone. You can conquer science but only by obeying her. The conquest of science is impossible without obeying the law of science and in order to know the laws of science you have to work in a spirit of humility and dedication.

I hope the imperative questions that have been raised in the various papers, which have been circulated, will find answer from this distinguished gathering.

I am very grateful to the organisers of this Seminar, who have given an opportunity to a layman like myself to speak a few words to you.

Thank you all once again.'

Proposing a vote of thanks to the guests and members present, Shri S. N. Sinha, Retiring Chairman, Bihar Centre, said:

' It is now my most precious privilege to express our sincere thanks for your presence in our midst this afternoon.

We are specially grateful to our Chief Minister who by his presence and advice given us impetus for our deliberations to follow. Sir, we are conscious of the great responsibilities on the Engineers, as Nation's principal servant. Each subsequent plan grows in size and complexities. But just as, higher the peak, greater the attraction to a mountaineer, so does the problems and complexities makes the task more alluring and fascinating. We, as our predecessors in the profession through the ages, approach the task with single minded devotion, sincerity and with sense of service and sacrifice. But we are neither complacent—and hence the often heard anxiety,—'Is the Engineer being given the position commensurate to his role so that he can serve the Nation properly and efficiently?' The answer would be easily, 'No'.

It is true that posterity, (I am almost tempted to add, if there be one) would never forgive if this generation fails to sacrifice itself for a brighter 'tomorrow', but is it not equally true that in case of, God forbid, a failure, the posterity would seek the cause. Historians are very patient and minute searchers. They discover and record, which one particular wrong order caused the failure in war or peace. Would they not truthfully record, that those who were given the responsibility were denied the position and trust to fulfill the tasks, and that too inspite of the saying of the national leaders. I refer, Sir, to the general guidance given to the Standing Committee of National Development Council by our late Prime Minister, Jawaharlal Nehru, when addressing it in January, 1956, he said:

> 'Scientific and Technical personnel should be introduced not only in the technical process, but in the administration also. After all—all problems todays are problems of science and technology. An able administrator, or an able politician, just as an able lawyer can grasp the broad outlines of a problem, but it is another thing to have grown up with all the processes. I think, therefore, that scientist and engineers should be associated more and more with administration and planning'.

Even after 10 years of this policy directive from the highest office, there is no evidence of implementation. Future judgment of the times would be no consolation to us, and that is why while we deliberate or organisation and productivity, power and irrigation, agriculture and communication, research and training, may we request you, Sir, to give your most valued and careful consideration to this vital and important aspect so that we can give our very best service to the people. As a prime mover of *zamindari* abolition you gave the doctrine 'Land to the tiller'. There is need of a similar doctrine of 'position and power to the doer', direct instead of through intermediaries which filter, distorts and sometimes pollutes our services.

I once again, extend you, Sir, our most honoured guests, heartfelt thanks and gratitude on behalf of the President, the Council and the members of the Institution for having graced this occasion and given us your valued advice and patronage. I also most sincerely thank you, ladies and gentlemen for having come and been with us this afternoon.

Thank you very much !

Jai Hind'

The Ninth Sir Mokshagundam Visvesvaraya Lecture

Dr. T. Sen, Past-President, then delivered the Ninth Sir M. Visvesvaraya Lecture between 9.30 a.m. to 10.30 a.m. on January 31, 1966 (see pages 71-87).

Shri S. N. Sinha, Education Minister of Bihar, presided.

Dr. K. L. Rao, Union Minister of Irrigation and Power also attended the Lecture after the start.

Upon the conclusion of the Lecture, Shri Sinha thanked Dr. Sen for delivering the Lecture and complimented Dr. Sen on the excellent exposition of the subject, 'Vision for the Future—The Industrial India of Visvesvaraya's Dream'.

Dr. K. L. Rao, Union Minister of Irrigation and Power, then spoke briefly bringing out the wide implications of the subject of the Lecture for the present context of India's struggle for self-reliance in the economic field.

Shri K. K. Nambiar (M.) then proposed a vote of thanks to Shri Sinha for having presided over the function and to Dr. Rao for having attended the Lecture in spite of his busy programme.

Inaugural Session, Monday, January 31, 1966

The Inaugural Session was held in Rabindra Bhavan, Patna, on Monday, January 31, 1966, at 11.00 a.m.

Shri Y. B. Chavan, Union Minister of Defence, inaugurated the Session. He arrived at the Bihar Centre building at 11.00 a.m. accompanied by the Governor of Bihar, Shri M. Ananthasayanam Ayyangar, and Dr. K. L. Rao, Union Minister of Irrigation and Power. He was received by Shri R. L. Singh Yadav, Minister for Public Works, Public Health and Home Guards and Chairman of the Reception Committee, Bihar Centre, Dr. T. Sen, Past-President and Shri S. N. Sinha, Retiring Chairman of the Bihar Centre, and introduced to the President-Elect, Shri B. P. Kapadia, Past-Presidents and Members of the Council for the Session 1966-67.

This was followed by a Group photograph.

Messages for the successful Convention were received from the following:

Dr. S. Radhakrishnan, President of India, Dr. Zakir Husain, Vice-President of India, Shri M. Ananthasayanam Ayyangar, Governor of Bihar, Dr. A. N. Khosla, Governor of Orissa, Shri Raj Bahadur, Minister of Transport, Dr. Ram Subhag Singh, Minister of State for Railways, Shri B. R. Bhagat, Minister of Planning in the Ministry of Finance, Shri L. N. Mishra, Deputy Minister for Home Affairs, Dr. M. S. Thacker, Member, Planning Commission, Shri Binodananda Jha, Ex-Chief Minister of Bihar, Sir J. J. Ghandy, Shri Dildar Husain, Past-President, Dr. T. Sen, Past-President, Prof. N. S. Govinda Rao, Past-President, Shri B. P. Kapadia, President, Shri G. Pande, Vice-Chancellor, Roorkee University, and Dr. K. K. Datta, Vice-Chancellor, Patna University.

The party arrived at Rabindra Bhavan at 11.15 a.m. for the Session.

At the commencement of the Session, the song "*Vande Matharam*" was sung and the members stood in silence.

1. Shri R. L. Singh Yadav, Minister for Public Works, Public Health and Home Guards, Bihar and Chairman of the Reception Committee of the Bihar Centre, welcomed the delegates to the city of Patna as follows:

'On behalf of the Government and people of Bihar, the Bihar Centre of the Institution and on my own, I welcome you to this ancient city of Patna for the Forty-sixth Annual Convention of the Institution of Engineers

(India). Formerly known as Patliputra, this city has a long and unbroken history which reads like a mythological saga. Founded by Ajatshatru, it has known unparalleled glory as the capital of Chandragupta Maurya, and the great Ashok. Scattered around our city are vestiges of our glorious past, at Rajgir, Nalanda and Bodh Gaya. You will, no doubt, those of you who have come from the distant corners of the country, take this opportunity of visiting some of these reminders of ancient India.

1. With this rich cultural heritage behind it, Bihar has set its sights at a future that will not be any less modern than that of the rest of the country. The steel city of Jamshedpur, the largest fertiliser plant in Asia at Sindri, the coal mines of Dhanbad and Jharia, the fast developing industrial complex of Ranchi, the dams of the Damodar Valley Corporation with their ancillary industries, all these are places of pilgrimage and reverence no less important than the ones I have mentioned earlier. Bihar, with its immense natural resources in the shape of ores and minerals. has a great contribution to make in the nation's future, a future which cannot be built without the assistance of you gentlemen, the engineers gathered here and your colleagues also all over the country.

2. Although the Engineers have made important contributions from the beginning of civilisation to the pre-Independence days, their importance today in the development of the country is greater than ever before. The development of irrigation, hydro-electric and thermal power projects and an efficient network of highways are the very basic needs for any developing economy. The persistent threats to our frontiers and the unsatisfactory economic situation demand relentless efforts from our Engineers. It gives me great pleasure to inform you that in Bihar they have achieved what they were asked to, efficiently, economically and within a very tight schedule. I am proud to have been associated with some of these achievements, even though my contribution has been meagre in comparison to that of engineers.

3. The Institution, which is the premier organisation of its type in the country, has a very important and responsible part to play in bringing together engineers for a constructive exchange of ideas and experiences, both theortical and practical. I am glad to inform you that the membership of the Bihar Centre has risen from ninetynine in 1947 to 3,200 today. The land on which the building of the Centre now stands was donated by our late Chief Minister, Dr. S. K. Sinha, a great patron of the sciences.

4. I would not like to take up too much of your time in giving details of the achievement of the State's engineers since independence. You are no doubt eager to disperse to your various seminars and down to the business you are really gathered here for and your colleagues from Bihar will no doubt be telling you of the projects completed and under way. This information will also, no doubt, be available from the office of the Convention.

But I would like the mention about the project of a bridge over the Ganga at Patna. This, I believe, presents a challenge for engineers due to peculiar river conditions but in view of its prime importance to the people of the State, they, the Engineers, will certainly overcome it.

5. I have attempted to indicate very briefly what has been going on in the State with a view to give you an idea as to how we feel about the present need of engineers and I am sure this is the position in other States also. We are trying to develop a self-sustaining economy in the country and to lay its foundation on sound lines. You engineers have been playing a very important role for which posterity will be grateful, more so because you have sacrificed certain gains, which would have come your way elsewhere, in helping to build the country and set it on the road to progress and prosperity.

6. I am glad to note that you are holding a Seminar on the role of engineers in the Fourth Five Year Plan. I have no doubt that out of these deliberations will come concrete suggestions which the country's planners will be able to put to good use. I would also request you to see how far you can equate maximum efficiency with economy for the one without the other would be little benefit.

7. I would not like to take more of your time since I am sure you must be very anxious to hear Shri Chavan who carries a very heavy burden as the Defence Minister of India, but has yet graciously found time and consented to inaugurate this Convention, for which we owe him our heartfelt thanks.

8. I once again welcome you to this city, this State, and earnestly hope that the Convention will be highly successful, towards which we have tried to spare no efforts.

9. I must also express my deep sense of appreciation and thanks to those who have spared no pains for making necessary arrangements for the Convention. I once again accord a very warm and hearty welcome to you all.

Jai Hind'.

2. Dr. T. Sen, Past-President, who was acting on behalf of the retiring President, Prof. N. S. Govinda Rao, who was suddenly ill on the way to Patna, then requested the Deputy Secretary, Shri D. K. Ghosh, to announce the award of prizes by the Council.

Shri Ghosh announced as follows:

(1) The Corps of Engineers Prize

This prize has been awarded to Dr. C. K. Ramesh, A.M.I.E., for his paper entitled 'Computational Aids and Modern Electronic Computers', published in the November 1964 issue of the Civil Engineering Division Part of the *Journal*.

(2) The Railway Board's First Prize

This prize has been given to Sarvashri Iqbal Singh and G. S. Ahluwalia, A.M.I.E., for their paper entitled 'Locomotive Workshops of Northern Railway at Amritsar' published in the January 1965 issue of the Civil Engineering Division Part of the *Journal.*

(3) The Railway Board's Second Prize

This prize has been awarded to Prof. B. S. Murthy, A.M.I.E., and Mr. L. G. Pless for their paper entitled 'Effectiveness of Fuel Cetane Number for Combustion Control in Bi-Fuel Diesel Engine', published in the March 1965 issue of the Mechanical Engineering Division Part of the *Journal.*

(4) The Union Ministry of Irrigation and Power Gold Medal and Cash Award (for Civil Engineering Aspects of River Valley Development)

This prize has been awarded to Dr. H. L. Uppal, M.I.E., and Sarvashri T. D. Gulati and Gajinder Singh for their paper entitled 'Plugging of Right Diversion Tunnel after Failure of Hoist Chamber at Bhakra Dam' published in the January 1965 issue of the Civil Engineering Division *Journal.*

(5) The Union Ministry of Irrigation and Power Gold Medal and Cash Award (for Power Development)

This prize has been awarded to Dr. S. C. Das Gupta, A.M.I.E., and Shri A. K. Roy for their papers: Application of Monte Carlo Method for the Analysis of D.C. Electric Network; Application of Monte Carlo Method for the Solution of a D.C. Network from Node Equations; Application of the Monte Carlo Method for the Evolution of the Transfer and Driving Point Admittance of a System; and Application of Monte Carlo Games in the Analysis of A.C. Network'.

(6) Sir Arthur Cotton Memorial Gold Medal

This prize has been awarded to Sarvashri B. Pant, A.M.I.E., and S. S. Patil for their paper entitled 'Study on Stress Distribution around Underground Surge Tanks in Relation to Structural Design' published in the May 1964 issue of the Civil Engineering Division Part of the *Journal.*

(7) Sir Ganga Ram Memorial Gold Medal

This prize has been awarded to Shri A. P. Rao, A.M.I.E., for his paper entitled 'Engineering Design Aspects of Rourkela Fertilizer Projects' published in the June 1964 issue of the Chemical Engineering Division Part of the *Journal.*

(8) Pandit Madan Mohan Malaviya Memorial Gold Medal

This prize has been awarded to Sarvashri K. Madhavan, A.M.I.E. and A. N. Singh for their paper entitled 'Analysis and Design for Satisfactory Governing of Hydroelectric Stations' published in the April 1964 issue of the Electrical Engineering Division Part of the *Journal.*

(9) Sir Thomas Ward Memorial Gold Medal

This prize has been awarded to Sarvashri N. K. Gupta and B. P. Bhattacharyya, A.M.I.E., for their paper entitled 'An Aspect of Bang-Bang Control Problem' published in the September 1964 issue of the Electronics and Telecommunication Engineering Division Part of the *Journal.*

(10) Jawaharlal Nehru Memorial Gold Medal

This prize has been awarded to Prof. P. S. Kalwachwala, A.M.I.E., and Prof. A. K. Mehta, A.M.I.E., for their papers entitled (i) 'The Teaching and Examination Structure of the Five-Year Integrated Courses', and (ii) 'Equipment Planning for Technical Institutions' published in the Proceedings of the Seminar on 'Technical Education and Its Development (1966-81)'.

(11) Sir Rajendra Nath Mookerjee Memorial Gold Medal

This prize has been awarded to Dr.-Ing. B. K. Ray and Shri A. M. Das, A.M.I.E., for their paper entitled 'Influence of Fuid Properties in Heat Transfer with Reference to Heat Exchangers' published in the January 1965 issues of the Mechanical Engineering Division Part of the *Journal.*

(12) Nawab Zain Yar Jung Bahadur Memorial Gold Medal

This prize has been awarded to Sarvashri R. L. Gandhi and M. Chandra, A.M.I.E., for their paper entitled 'Comparative Study of MF Technique and MPN Procedure' published in the February 1965 issue of the Public Health Engineering Division Part of the *Journal.*

(13) Institution Prize

An Institution prize has been awarded to Dr. B. B. Sundaresan, A.M.I.E., for his paper entitled 'Basic Mechanism of the Anaerobic Digestion of Sewage Sludge' published in the February 1965 issue of the Public Health Engineering Division Part of the *Journal.*

(14) Institution Prize

Another Institution prize has been awarded to Shri P. K. Mukherjee, M.I.E., for his paper entitled 'Culverts Under High Fills' published in the November 1964 issue of the Civil Engineering Division Part of the *Journal.*

The prizes were announced by the Deputy Secretary, and were given away by the Chief Guest to those present.

3. The Governor of Bihar then conferred the Honorary Life Membership of the Institution on Shri Dildar Husain and called upon the Deputy Secretary, Shri D. K. Ghosh, to read the citation for Shri Dildar Husain. Shri Ghosh read the citation as follows:

'Shri Dildar Husain graduated in Civil Engineering from the University of Bombay in 1918. A short sketch of his activities as student appeared in the 'Under-graduates Cocktail', published by the A. P. Centre on the occasion of the 44th Annual Convention of the Institution of Engineers (India), held in Hyderabad in 1964. During the period of his post-graduate apprenticeship in hydrology, under Mr. R. B. Joyner, C.I.E., Hydro-electric Expert for the design and construction of the masonry dams for hydro power in the Western Ghats, projected by the Tata Power Company, Bombay, Shri Dildar Husain received a more lucrative offer, but being as State Scholar it was obligatory on him to join service in the Hyderabad P.W.D., which he did accordingly.

The First World War had just then ended, and the Government of Hyderabad were considering their responsibility for the water supply to the cantonments of Aurangabad and Jalna (now in Maharashtra). Shri Dildar Husain was posted as the Engineer-in-Charge of the operations. He was sent for special training at Ahmednagar under Colonel Festing, Specialist from Egypt and Mesopotamia in the design of Emergency Water Supply Schemes. On his return, he had to submit the design for a scheme of the water supply for the town of Jalna, a project comprising an earth-dam and an infiltration gallery, in a region of black cotton soil across the Kundalika River, a tributary of the river Godavari.

He had to carry out not only the design but later on the construction of a large earth-dam on the theory of Strange, on the completion of which, his services were openly commended by the then Prime Minister, Sir Syed Ali Imam, formerly Law Member of the Government of India, who incidentally hailed from Patna, Bihar. The scheme was successfully completed and the town of Jalna now boasts of filtered water supply.

In the Mahrashtra region of Aurangabad, Shri Dildar Husain carried out works of some very difficult hill roads, which had defied the skill of his predecessors, such as the roads leading to the world famous Ellora and Ajanta Caves, besides constructing numerous bridges, both of the deck type and the submersible ones, across the numerous rivers which drain from the Deccan Plateau into the Godavari River.

He was also responsible for the construction of the reinforced concrete bridge across the Godavari River at Shahgadh (Maharashtra), built by the Hindustan Construction Co., and for which Shri Dildar Husain received the first prize of a Bronze Medal awarded by the Indian Roads Congress for the best technical paper for the year.

Shri Dildar Husain, after becoming Executive Engineer, was responsible for the survey and design of the first largest canal system in the State of Hyderabad, known as the Nizam Sagar Project. He had to deal with the construction of the entire canal system for irrigating about 3 lakhs of acres of single and double crop irrigation. Alongside the construction of the canal system, he was required to complete the work of the unfinished Dam, on the promotion of the Superintending Engineer-in-Charge.

About the year 1938, when the canal system was formally opened by H. E. H. the Nizam, Shri Dildar Husain's services were publicly appreciated in H. E. H. the Nizam's Inaugural Address.

The State of Hyderabad decided to instal the first Sugar Factory in the canal area, following the example of the Mandya Sugar Factory in Mysore. Shri Dildar Husain carried out a good deal of Town Planning and surveys in connection with the location of the Sugar Factory and the work of development for the town and villages coming under the influence of the factory. For this his services were duly appreciated and in course of time he was awarded by the Nizam's Government, what was then known as the Asafia Gold Medal, for meritorious services.

After being promoted as Superintending Engineer, he was placed incharge of the construction of a Public Health Project, Tuberculosis Hospital-cum-Sanatorium in the Anathagiri Hills, for 300 in-patients. The scheme was successfully completed and was highly appreciated by suffering humanity.

His work as Superintending Engineer, prior to his promotion as Chief Engineer, coincided with the initiation of the Tungabhadra Reservoir Project which was then a joint venture between Hyderabad and Madras. He was responsible for the construction and design of numerous medium size storage reservoirs, both earth and masonry dams, for irrigation, largely in the arid zones in Maharashtra and in State of Hyderabad.

He had also prepared standard designs, for Highway Structures, in four volumes, for the benefit of the P.W.D. of the State of Hyderabad.

The State of Hyderabad had a composite service of P.W.D., but Shri Dildar Husain submitted a scheme for creating an independent irrigation Department, which was sanctioned by the Government, and he became the first Chief Engineer for Irrigation. He was responsible for the establishment of the first Engineering Research Station in Hyderabad to deal with problems of Hydraulics, Dissipation of Energy, Design of Hydraulic Structures, Soils and Rock Mechanics and General Engineering. Problems of river training and flood control were also brought under special study, largely under the direction of the then Prime Minister, Sir Mirza Ismail, who intended to beautify the city of Hyderabad and other towns in the state.

After his retirement, Shri Dildar Husain became associated with the Osmania University for which he had translated several books on Civil Engineering for the B. E. Degree course. Later, he was appointed Civil Engineering Expert and Consultant to the Osmania University.

Studious by nature, he was responsible for the commemoration volume of 'A Century of Irrigation' for the centenary of General Sir Arthur Cotton. 'A Century of Irrigation' being the name of the volume, it was released by Sir Malcolm Macdonald, British High Commissioner, when he unveiled the portraits of famous Royal Engineers, General Sir Arthur Cotton and General Orr, builders of the Godavari and the Krishna anicuts and the canals respectively, and Col. Pennycuick, builder of the Peryar Dam, in the State of Travancore, now Kerala.

Shri Dildar Husain was appointed a Member of the Bhakara Nangal Enquiry Commission, set up by the Government of Punjab, from 1956 to 1958. He was later appointed a Member of the Water Utilization Enquiry in the River Valley Projects for the States of Punjab, Uttar Pradesh, Rajasthan, Bihar, West Bengal, Orissa, Jammu and Kashmir for which he submitted 10 volumes of reports to the Government of India, in 1959. He was appointed Consultant to the Central Water and Power Commission, Ministry of Irrigation and Power, Government of India, in 1966, and continued from 1962 to 1964, for which he received high appreciation from the Government of India for 'his valued advice and assistance as Consultant to the Ministry'.

Shri Dildar Husain is a full member of the Institution of Civil Engineers, U.K., and also a Member of the International Association for Hydraulic Research, which brought him in touch with the late Andre Coygn, especially in connection with stabilization of old masonry dams by means of anchorages, e.g., Walwhan Dam.

Shri Dildar Husain is the author of several books, such as a short biography of 'an Engineer Statesman of Hyderabad', Nawab Zain Yar Jung, Past President of the Institution, and 'Illustrious Profiles' being short biographical sketches of the only four Past-Presidents of the Institution from U.P., recently released from the press. He has been a contributor to Engineering journals in India and abroad.

He was a member of the Re-organization Committee of the Survey of India, under the Ministry of Scientific Research and Cultural Affairs, 1961-62, which resulted in the recommendation of a scheme, also approved by the Government of India, for establishing a Central College of Training for Surveying in Hyderabad.

Shri Dildar Husain was also a Member of the Technical Advisory Committee, Planning Commission, Government of India, for a number of years, as a representative of the Institution of Engineers (India).

Shri Dildar Husain has been a Member of the Executive Council of the Central Building Research Institute, Roorkee. He has also been appointed Member of the Executive Council of the newly-formed Structural Engineering Research Centre, Roorkee, the scheme for which was formulated by Shri Dildar Husain as Chairman of the Civil Engineering and Hydraulic Research Committee.

Shri Dildar Husain has had wide contacts with several Engineering Colleges in India and is currently a Member of the Board of Governors of the Regional Engineering College, Trichurapally. His services to the Institution of Engineers (India) are well-known, especially as Convener of the Flood Committee, and the Re-organization Committee appointed by the Council in 1961, which gave a new orientation to organization in the Head Office and at Local Centres.

He is Member of the Advisory Committee for Technical Education in Andhra Pradesh, besides being a Member of several literary and historical societies.

He is practising as an Engineering Consultant during his spare time.'

The Governor of Bihar thereupon presented the Scroll of Honorary Life Member to Shri Dildar Husain. Shri Dildar Husain signed the register of Honorary Life Membership. (*Applause*).

The Governor of Bihar then conferred the Honorary Life Membership of the Institution on Sir Jehangir Jivaji Ghandy, and called upon the Deputy Secretary, Shri D. K. Ghosh, to read the citation for Sir Jehangir Jivaji Ghandy. Shri Ghosh read the citation as follows:

'Sir Jehangir Jivaji Ghandy was born on 18th November, 1896 in Bombay, his father, Shri Jivaji Dinshaw Ghandy, being a solicitor of repute; and a Director of Tata Sons Limited and several other Tata Companies.

He was educated at the New High School and at St. Xavier's and Wilson Colleges, Bombay, taking his B.A. with Honours in Physics and Chemistry and B.Sc. (Chemistry Hons.) in 1916 and 1917 respectively.

After some eighteen months' general practical training in the works of the Tata Iron and Steel Co. Ltd., Jamshedpur, he left for the U.S.A. in 1918 and completed post-graduate studies in Business Administration at the Columbia University, New York, and in Metallurgical and Steel Works Engineering at the Carnegie Institute of Technology, Pittsburgh. He studied in the U.S.A. for about three-and-a-half years, working in different steel plants during the summer.

In 1921, at the age of 25, he rejoined the Steel Company at Jamshedpur as Metallurgical Engineer, and was promoted as Assistant Superintendent, Blooming and Rail Mill, in 1923, and as Superintendent of the Bar Mill in October in the same year. In 1924, he was made Superintendent of the Blooming and Rail Mill and Bar Mills, and in 1925, was appointed Assistant General Superintendent in Charge of all the Rolling Mills, a post which he held for five years.

In 1930 he was appointed General Superintendent of the Works and was mainly instrumental in cutting down costs, eliminating waste and in steering the Steel Works successfully through the economic depression of the early thirties. He was appointed Deputy General Manager in May 1937, and in January 1938, was promoted as General Manager, being the first Indian to hold this high position. His outstanding work as an organizer of production received further recognition when he was promoted as Agent of the Steel Company in 1944. In 1945, he was appointed Director of Tata Industries and in April 1954, Director-in-Charge of the Steel Company. A more significant recognition of his outstanding ability, as one of the foremost administrators in the country, came in August 1959, when he was appointed Director of Tata Sons, the parent firm controlling the Tata Group of companies.

He is also the Chairman of West Bokaro Ltd., Belpahar Refractories Ltd., Tata-Robins-Fraser Ltd. and of the Indian Tube Co. (1953) Ltd. He is a Director on the Board of Tinplate Company of India Ltd., and Bisra Stone Lime Company Ltd.

He is a Fellow of the Institute of Fuel, Great Britain, Honorary Member of the Iron and Steel Institute, Great Britain, Member of the Council of the Institution of Engineers (India), and a Past-President of the Indian Institute of Metals.

Sir Jehangir is a member of the Governing Body of the Council of Scientific and Industrial Research and Chairman of its Metals Committee. He was a member of the Industrial Research Planning Committee as well as of the Iron and Steel (Major) Panel set up by the Government of India. In May 1965, he visited U.K. and U.S.A. as a member of the non-official Mission of Indian Industrialists. He has been a member of the Iron and Steel Advisory Committee set up by Government. He is a Member of the Council of the Indian Institutes of Technology; Chairman, Eastern Regional Committee of the All-India Council for Technical Education; Chairman of the All-India Board of Technical Studies in Management, and Member of the Court of Governors of the Administrative Staff College. He is also a Member of the Indian Advisory Committee of the Nuffield Foundation and Member of the Indian Committee of Lloyd's Register of Shipping, and Member, Board of Governors, of the Indian Institute of Management, Calcutta.

Sir Jehangir has been Chairman of the Structural and Metals Division Council of the Indian Standards Institution since its inception in 1956. He is also Vice-President of I.S.I. and Chairman of its Executive Committee.

Sir Jehangir Ghandy has been taking keen interest in the industrial development of the country in general and of the States of Bihar and

Orissa in particular. He is a Member of the Bihar Industrial Development Council and Chairman of the Technical Committee of the Council. He is also a Member of the Orissa Industrial Development Committee.

Sir Jehangir Ghandy initiated for the first time in India the 'Techno-economic' Survey or 'Technological Audit' of a selected region. The survey makes a realistic assessment of the natural resources, economic problems, and the industrial and economic potential of an area. It indicates broadly the guide lines on which a planned programme for future development can be formulated, and also gives estimates of investments needed. The National Council of Applied Economic Research, which is an independent body, has completed the Techno-economic Survey of almost all the States in collaboration with experts from Stanford Research Institute, California.

Sir Jehangir was appointed Chairman of the Heavy Engineering Committee set up by the Government of India to assess the reports by the Soviet Team and the U.K. Mission regarding establishment of the Heavy Engineering Industry in India.

Sir Jehangir was largely instrumental in arranging for the orientation course, in Jamshedpur, for about one thousand Indian engineering graduates who were selected for the Government Steel Plants, and for their subsequent training in the U.S.A.

As Vice-President of the Acharya Jagadis Chandra Bose Birth Centenary Committee, Sir Jehangir initiated a scheme of science talent search, know as the Jagadis Bose National Science Talent Search. This scheme, the first of its kind in the country, and at present confined to the state of West Bengal, is now being administered by a Governing body, of which Shri P. C. Sen, Chief Minister, Government of West Bengal, is the President and Sir Jehangir the Chairman. The first scholarships were awarded in 1961 and the second in 1962. At the instance of Sir Jehangir, the Council of Scientific and Industrial Research is studying proposals to extend the Science Talent Search to the rest of the country. At his instance this Council has also agreed to provide a grant of Rs. 10,000 annually for the Jagadis Bose National Science Talent Search.

Sir Jehangir was made a C.I.E. in 1941 and knighted in 1945. He was made an Honorary Lt.-Col. in the Territorial Army in 1952 and an Honorary Colonel in April, 1957.

He was awarded the Padma Bhusan on Republic Day, 1958. In November, the General Assembly of International Organization of Standardization (I.S.O.) elected him as President of I.S.O. for three years from January 1965.'

Sir Jehangir Jivaji Ghandy could not be present to receive the Scroll of Honoray Life Member in person.

The Governor of Bihar then conferred the Honorary Life Membership of the Institution on Dr. T. Sen and called upon the Deputy Secretary, Shri D. K. Ghosh, to read the citation for Dr. T. Sen. Shri Ghosh read the citation as follows:

'After graduating in Mechanical Engineering in 1926, Dr. Triguna Sen started his career as an Instructor in the College of Engineering and Technology at Jadavpur.

In 1929 he was awarded the Deutsche Academic Scholarship for post-graduate studies in engineering in Germany. He obtained his Doctorate in Engineering from the Technical University in Munich, specializing in Hydro-mechanics. In 1932, he worked in different firms and corporations in Germany. During his stay in Germany he noticed with interest the behaviour of the Nazis under Hitler towards the Indians, only because Indians were being ruled by the British, and his feelings had great influence on his actions. He was thrown in active freedom-fighting movement. The then British Rulers waited for his return and as soon as he came back to India in 1932 he was arrested under Bengal Ordinance, put in a detention camp and after one year was externed from the then Presidency of Bengal.

From 1933 to 1943 he travelled to many places and worked as Engineer and Manager in different industrial concerns outside Bengal. When the ban upon him was lifted, Dr. Sen was called upon to organize the College of Engineering and Technology, Bengal, as Administrative Officer and was appointed as Principal of the College in 1944.

Under his guidance the College of Engineering and Technology, Bengal, had been virtually functioning as a University and the Government of West Bengal, with the concurrence of the Government of India, enacted the necessary legislation for the establishment of a University at Jadavpur under the name, 'Jadavpur University', which came into being on the 24th day of December, 1955, and Dr. Sen was appointed the first Rector (Vice-Chancellor) of the University. In 1964 the Government of West Bengal amended the Jadavpur University Act and the designation 'Rector' was changed to Vice-Chancellor.

It is significant that the day of birth of Dr. Sen (24th day of December) coincide with the date of the establishment of Jadavpur University.

In 1957 Dr. Sen went to America and Europe to study the system of education in different Universities. Again in 1959 he went to Germany to study the administration of Universities, in 1960 to France to study the system of education in higher secondary schools there, and in 1963 to Czechoslovakia to study the system of University and Technical education.

In addition to his duties as Vice-Chancellor of Jadavpur University, Dr. Sen was elected Mayor of Calcutta in 1958 and again in 1959. He was President of the Association of Principals of Technical Institutions in India for two terms, in 1961 and in 1962. He was elected President of the Inter-University Board of India and Ceylon in 1963.

Dr. Sen was Chairman of the Bengal Centre of the Institution of Enginers (India) for 1951-52, and a member of the Council for 12 years. He was elected President of the Institution of Enginers (India) for 1962-63, and then again for 1963-64.

He is a member of the Institution of Mechanical Engineers (London).

He is connected with different universities and institutions of higher learning, several scientific, technical and cultural institutions, Board and Societies, both government and public.

He was a Director of the Central Board and Vice-President of the Local Board of the State Bank of India from 1959 to 1962. He is now a Director of the Central Board of the Reserve Bank of India.

Dr. Sen is a member of the Education Commission set up by the Government of India.

He was decorated as Padma Bhusan by the Government of India in 1965.'

The Governor of Bihar thereupon presented the Scroll of Honorary Life Member to Dr. Sen. Dr. Sen signed the register of Honorary Life Membership. (*Applause*).

4. Dr. T. Sen introduced Shri B. P. Kapadia, President-Elect for the Session 1966-67, in the following terms:

'Shri Beramshaw Pherozeshaw Kapadia, B.E., M.I.E., an outstanding figure in Indian engineering, has been elected President of the Institution for the session 1966-67. Shri Kapadia joined the Institution as an Associate Member in 1923 and was transferred to Member in 1938. He has been a member of the Council of the Institution for five years and was Chairman of the Bombay Centre in 1956-57, besides having served on the Committee of that Centre over a long period of years.

Born in Broach in October 1890, Shri Kapadia was educated in Broach High School and the Wilson College, Bombay, where he was a scholarship holder. He joined the College of Engineering, Poona, and took his B.E. degree in Civil Engineering from that College in 1916.

After a year's apprenticeship in a firm of architects, he was appointed as State Engineer in a Princely State. He also worked later in McKenzie Ltd., Bombay, specialising in reinforced concrete development. In 1920 he joined Marsland and Price Co., Bombay, which was at that time the oldest firm of R.C.C. specialists, as an engineer.

From 1920 to 1925 Shri Kapadia was responsible for all the major R.C.C. construction works and power houses for Tatas in Bombay and the adjoining areas as Works Manager of the firm. In 1926 Tata Construction Co. were appointed as Managing Agents of Marsland and Price Co. and Shri Kapadia was appointed Engineer-in-Charge of the work of realignment of the Bore Ghat section of the Great Indian Peninsular Railway near Bombay, which included construction of new tunnels, embankments, bridges, etc. These were completed in 1929.

In 1929-30 Shri Kapadia carried out the difficult work of widening the existing tunnels under traffic on the Bore Ghat and Thull Ghat. In 1931 to 1934, on behalf of Hindustan Construction Co., he executed a large number of civil and reinforced concrete work including a bridge in record time in Poona. During 1934-35 he completed several large works including reinforced concrete tanks, Osmania University, bridges, and water supply schemes in Hyderabad State.

In 1936 he proceeded to Quetta after the great earthquake, and as Works Manager for the firm, carried out the earthquake proof reconstruction of the entire city, the work which lasted till 1939. From 1939 to 1942 he had a special assignment in Ceylon in connection with the hydroelectric project at Norton Bridge and was in charge of the construction of the concrete dam, many tunnels, pressure pipelines, power houses, etc. during the Second World War.

From 1942 he was again in charge of all works in Bombay including the Premier Automobile Works. embankment cutting in the Tansa pipeline works, and all underground work of new tunnels in Thull Ghat, Igatpuri, etc.

In 1946 he became Deputy General Manager of the H.C.C. for the Bombay Zone. Along with all works in Bombay he had charge of all underground works relating to the Tungabhadra project in Hyderabad and the Maithon project in the Damodar Valley Corporation.

In 1948 he became General Manager of the Company. In the next 15 years in this high capacity his most outstanding achievements were the construction of the Koyna hydroelectric project including the underground power house, tunnels, and all tunnels and R.C.C. works of the Sharavati project in Mysore State. Shri Kapadia became widely known as an authority on underground and tunnelling works. He retired as General Manager in May 1963.

From then to mid-1963 he acted as Consultant to the Hindustan Construction Co., finally retiring from the Company in September 1965. He, however, still continued to practise as a Consultant but mostly for work relating to arbitration.

Besides his connection with the Institution, Shri Kapadia has been widely connected with other engineering organizations during his long and brilliant career as a civil engineer. He has been a Member of the Building Division Council of the Indian Standards Institution and also many of its Committees. He is also a Past-Chairman of the Engineering Association of India. He is a founder-member of the Builders Association of India and was its President for four years. The Association made him an Honorary Life Member in recognition of his long and exceptional services. He was a delegate of the All-India Employers Association to the Building, Civil Engineering and Public Works Committee meetings of the International Labour Organisation, Geneva, in 1949, 1951, 1956, 1959 and 1964. At the I.L.O. Convention in 1956 he was elected Vice-Chairman of the Employers Groups in the Committee. In 1965 he was nominated by the All-India Employers Association as an expert in 'Safety' to the Governing Body of the I.L.O.

Shri Kapadia is a Freemason and holds very high ranks in those institutions, and a Lion. He is connected with a large number of social organisations where his extreme outspokenness, integrity, cheerful disposition and hard work have endeared him to all. His premier relaxation is horse-racing of which he is very fond.'

Dr. T. Sen then installed Shri B. P. Kapadia as President for 1966-67. (*Applause*).

5. Shri B. P. Kapadia said that his first duty as President of the Institution was a pleasant one of conferring the Presidential Scroll of Honour upon the retiring President, Prof. N. S. Govinda Rao. However, since Prof. Govinda Rao could not be present in the Convention, it was decided to send the Scroll of Honour to him subsequently. (*Applause*).

6. Shri B. P. Kapadia then delivered his Presidential Address. (See pages 55-70).

7. Shri Y. B. Chavan, Union Minister of Defence, next delivered the Inaugural Address:

'The President, Members and Friends,

I should like to thank you, Members of Institution of Engineers, for inviting me to your Annual Convention. I am fuly aware of the role and functions of your Institution and I am conscious of its growing importance. I have studied your Charter and noted with interest the reorganisation which has taken place, particularly the constitution of seven divisions to cover the different disciplines of engineering. This reorganisation is an indication of your desire to attract members from all branches of engineering and also to remain united as a professional body to be able to speak with one voice. I am sure that this will create unity and comradeship in the profession as a whole.

2. Your President has referred to the greatest tragedy that overtook our country recently. Lal Bahadurji was devoted to peace throughout his life. He died in a foreign country where he had gone on a mission of peace. Throughout his short but glorious tenure as Prime Minister, he showed himself to be a great leader and a wise statesman. His ceaseless efforts led to the signing of Tashkent Declaration which has brought hope of peace and happiness in this part of the world.

3. Peace is essential for achieving the main objective before us, namely, betterment and prosperity of making. In this great effort, scientists and engineers have a very important role to play. The real enemies of mankind are—poverty, disease and ignorance. Science and technology are the new tools in our hands which have given us hope to conquer these enemies within a short period of time. Engineers and Scientists, as masters of these tools, have, therefore, assumed special importance. It is possible that their role is not yet fully appreciated by the common man. But this is not surprising as we are late starters in the field of modern science. In the pre-Independence days, the Government hardly took any interest in the technical field. The main contact of Government with the people was in the field of Law and Order and collection of taxes. The general administrator therefore became all powerful in the eyes of the people and everyone else assumed a secondary place. The superstitious role of importance of the administrator is thus a legacy of the British days. This situation must now change and the scientist, engineer, artist and others with creative power must be given their due place. The administrator can also help this process by giving his wholehearted support.

4. Enginers and scientists are also being required to play more and more important role in the activities of the Government. There has been some debate about the precise role of a Specialist in Government functions. In the technical fields, the advice of the specialist is naturally of highest importance. I have had some experience of administration both in the State as well as in the Centre and I can say that the occasions on which the advice of a specialist is ignored are indeed very few. But it is important to remember that the advice of a specialist is only from one angle. The solution of any administrative problem, to put it in a technical language, is normally a function of more than one variable. In dealing with such a problem, apart from considering technical aspect, one has also to consider the economic, social and political factors involved.

5. The functions of a specialist and a generalist are therefore complementary and both are important in their own fields. What is necessary today is to utilise their talents in the best possible way for the benefit of the people. I do not want even to suggest that a specialist cannot prove to be a good administrator. In fact, many engineers have proved to be very capable administrators. But when they change their roles, the

country loses their talents in the specialised field. In our country where we have so few qualified men in different technical fields, it is a matter for consideration whether we can afford to divert their talents in merely administrative roles.

6. I think I must now turn to the general problems in the defence field. The first thing I would like to stress is that defence efforts are not incompatible with the policy of peace. In fact, in my opinion, they are complementary to it. Every country must be prepared to defend its freedom and territorial integrity. A country which has a good defence capability and which is politically and economically strong can become a factor in favour of peace because it forestalls the evil designs of a would-be aggressor.

7. I need hardly remind you that engineers have a vital role to play in the defence efforts of the country. Generally it is in peace time that you need to develop materials and techniques which could speed up construction under adverse and critical conditions, when manpower is difficult to get or deploy. The emphasis on quality and economy can never be relaxed as the security of our forces depends on the quality and durability of your engineering works. I suggest to you that your profession as a whole must constantly think of the future and an engineer has to keep alert and progressive in his outlook to take advantage of the latest developments in the field of equipment and materials. I have no doubt that you as a professional body would take interest in this direction.

8. There is an urgent requirement for us to develop our communication systems both from the economic and defence point of view. Speedy movement of men and materials, is an essential prerequisite for trade and prosperity, as also for the quick and effective deployment of our forces. Our communication systems are rather outmoded and inadequate. Crash programmes are required in the varying and diverse fields of road, rail and air communications. This is truly a challenge to the engineering profession, as also the keeping open of these communications with minimum of disruption and delay.

9. Unusual and unheard of problems are encountered in border areas and both men and machines function under great handicap and strain. These problems are to be studied and overcome and this is a field in which the Institution of Engineers could well play an important role. Your President has rightly stressed the importance of research and development. There are research and development units in the Defence sector for tackling problems in various fields. This effort, by itself, however, would not be sufficient. There is a greater need for harnessing the research and development effort of the nation and a concerted drive will have to be made to exploit the potential. Help and cooperation from technical institutions in the country and from industry in this respect would be highly valuable.

10. In this connection I must refer to the need of self-sufficiency in the field of industrial production. Defence preparedness is intimately linked with the industrial progress and the strength of a modern nation is measured in terms of its industrial potential and progress. I understand that the manufacturing units in this county in many fields are dependent to a great extent on components which have to be imported from abroad. Recent experience has shown that it is not in the country's interest to depend on other countries in respect of essential needs. We must therefore aim at achieving self-sufficiency in equipment. A logical corollary to this would be that we must now standardise and rationalise the type and variety of equipment to the absolute minimum. It is also necessary that there should be a self-imposed discipline among research workers, designers and manufacturers to utilise to the maximum possible extent only such components as are indigenously produced. I know that 'self-reliance' is something which can be easily said than done. Achievement of this aim will require very hard work on the part of everyone concerned and co-ordination of efforts in different sectors. The Institution of Engineers which embraces all the engineering faculties, is in a position to play a positive role in this respect.

11. I would now like to mention briefly about modern methods and techniques which have been developed in the last few years. These require the application of scientific methods to the study of operations of large complex organisations or activities taking into account such factors as chance and risk with which to compare and predict the outcome of alternative decisions, strategies and controls. The purpose is to help management determine its policies and actions scientifically. The term commonly used is 'operational research' and its practitioners are constantly seeking new ways of analysing situations and of understanding systems. The main characteristic is that it is interdisciplinary. An operational research team consists of men who are qualified in different subjects and who share their experiences in pursuit of a common aim. It is a scientific and mathematical analysis of a problem and seeks to achieve the maximum output in the most economical manner. In this country there is a certain measure of resistance to these new tools of management and decision making. It is up to you engineers to study and understand these, and to employ them so that we may make sound decisions.

12. It has often struck me that there should be greater cooperation and collaboration between civilian and military engineers, so that in times of need there is better understanding between the two and the entire technical resources of the country are bent towards the supreme goal of defending the country. Your institution serves such a purpose, and I further hope that many of the younger members would be attracted to a career in the Services, which offers interesting problems and a challenge to the youth of our country.

13. I would like to thank you once again and to say how happy I am to be with you this afternoon. I am greatly impressed by the strength and unity of your profession and conscious of the vital role you have to play in building up a strong and prosperous India. A heavy burden lies on your shoulders and the nation has every confidence in your ability. The future belongs to the engineering profession'.

8. The Governor of Bihar, Shri M. Ananthasayanam Ayyangar, then delivered his Address as follows:

'Mr. Chavan, Mr. President of the Institution of Engineers (India),
Ladies and Gentlemen,

I deem it a privilege to have been called upon to preside over the Inaugural Function of the 46th Annual Convention of the Institution of Engineers which has been so ably inaugurated by my friend, the Defence Minister. I am glad to find that the Institution has been working quite well all these years both before and after freedom was won but a fillip has to be given to your activities after the change-over from the previous Government to our own. During the British period they were running a Police State and the Government did not undertake the responsibility of starting industries or running them efficiently. The British themselves believed in the doctrine of *Laissez-faire* at home and projected that doctrine to our country also. That doctrine may be good enough for a country which has been industrialising itself for over two hundred years since the industrial revolution took place but while the industrial revolution was going on in the West we were under foreign domination and the benefits of the industrial revolution were not taken advantage of by our own people and by the Government. New industries were necessary in an underdeveloped country but the principles on which protection was given to us were very restricted. They themselves were in favour of free trade in their own country. They continued to judge us only in that light and even now the impression persists amongst them and to a large extent in America also, which are highly industrially developed countries in the world, that an underdeveloped country like ours should also develop free trade. This will result in a competition analogous to a race between a lame donkey and a race horse. Therefore as soon as we won freedom the Central Government appointed a Fiscal Commission and I was one of the members of that Commission. We revised the principles of granting protection and allowed protection even to embryonic industries in the making and not well-developed industries alone. Thereafter the Industrial Policy Resolution was passed at the Centre whereby the industries were divided into two categories—some assigned to the private sector and the basic and fundamental industries to the public sector. The Industries Control Act was also passed whereby the Centre has control over private industries and has to give license for industries where the capital is more than five lakhs of rupees. We have been working on these lines since then. It is well known that in the matter of agricultural and irrigational sources except a few private channels or tanks here and there the major projects, all belonged at all times to the State. We were poor both in agriculture and in industry in 1947 and both had to be developed.

Scientific knowledge both fundamental and applied is necessary both for agriculture and industry and for utilising that knowledge technical skill is called for. The work of construction by implementing the discoveries of science is legitimately the task of Engineers. As the youth of the previous generation fought for freedom and won it from the mighty British Empire it is up to you Engineers, both present and future, to give an economic content to that freedom and fight against not the Britishers today but against poverty, hunger, disease, squalor, dirt, unemployment and illiteracy.

You know that the biggest of our industry is agriculture and as many as 80 per cent of our population is engaged there. It cannot be said that even the agriculturist is well fed. Recently we had a deal with America for the import of 11 million tons of foodgrains from that country. We have put up a number of River Valley Projects and constructed dams across perennial rivers at the rate of at least one in each State and we can justly be proud that we have the tallest Dam in the world at Bhakra which goes up to a height of 750 ft. and the longest Dam in Hirakud the bund of which extends over 14 miles in length. All honour to our Engineers who have participated in these constructions. We have increased the production of cereals in our country from 43 million tons in 1947 to 73 million tons today partly by producing more in every field and partly by bringing as many as 3 million acres newly under cultivation by reclaiming land through the Central Tractor Organisation but still we are in want, as our population is growing. We have to produce twice as much or thrice as much in the same land, as land does not grow in extent along with the growth of population. The Fertilizer Factories are producing fertilizers and the demand for fertilizers is increasing day by day. The apathy to the use of fertilizers has disappeared and the *Kisan* longs to use fertilizers. We are unable to meet the demand for want of foreign exchange. For want of foreign exchange we are not able to import fertilizer machines. Naturally traders and business men outside our country would like to sell fertilizers to us rather than part with their factories or help us to put up fertilizer factories here. But the purchase of fertilizers to the tune of Rs. 35 or 40 crores will lead to a perpetual drain on our slender resources in foreign exchange. Therefore it is necessary that fertilizer factories in sufficient number to meet the growing demand of each State should be put up as quickly as possible. Huge fertilizer factories may be put up, but there may not be harm in putting up smaller units and this requires the skill and attention of mechanical and other engineers. The Heavy

Engineering Corporation was set up some years ago and with the collaboration of that Corporation, the Engineers must be able to design fertilizer factories and set them up as quickly as possible. There is no doubt a Design Section in the Central Board of Irrigation and Power but I believe that an All India Designing Corporation or an Institute with branches in each State must be set up and made to work efficiently and quickly. There is no time to lose. The 11 million tons of wheat can help us only for a short period to stave off our present difficulties. Unless we make up in the interval the future will be bleak. The supply of this deficiency is naturally in the hands of the Engineers. I am aware that the Engineers are busy with construction and have no time for research but research work must be developed quickly and extended. At this Convention you must try to devise means by which this deficiency may be made up. If you prepare the proper designs, the Government may take up the responsibility of putting up industries. It is said however that some of the raw materials for putting up the Plant have to be imported.

During my experience after we passed the Fiscal Commission Report I found that each industrialist required protection for his own industry and products thereof. He did not encourage other indigenous industries sometimes, even though they are protected on one ground or other as want of quality, price, etc. This lack of co-ordination is cutting at the root of our industrialisation.

A similar want of co-operation is sometimes due to provincial feelings which come into play. We have not yet imbibed, as a whole, a spirit of oneness in the country. I am aware that in the putting up of Dams across the Damodar in Bihar State and even the Hirakud Dam that has been constructed, the persons in charge of the Board in this State would not even care to see how the Hirakud Dam was being constructed by our own indigenous skill. For two or three years there was not a Chief Engineer for the Damodar Valley Corporation until one Mr. Savace was brought from America. We would rather prefer outsiders to come and help us even after 18 years of freedom than encourage our own men on some ground or other. This is unfortunate. I am sure that amongst yourselves you will discard all provincialism and choose the best person required for the particular work and for the country as a whole.

Lots of young engineers have returned after study and the obtaining of degrees after a long number of years in America, England and Germany and will see that some of them are not encouraged as much as they deserve. There is unfotunately a kind of jealousy between the old engineers who have passed their examinations 25 or 30 years ago and the younger generation with new knowledge and technical skill. This ought not to be allowed to grow.

Recently as Chancellor of the five Universities of this State, I had occasion to inaugurate Refresher Classes for Professors of Mathematics, Zoology, Chemistry and so on an All-India basis in some of our Universities here. Experts from America and other places also came. If you have not such a Refresher Course for the older generation of engineers, I wish that you start them as early as possible. I am not trying to accuse the old engineers. With their experiences they are superior to the younger ones but scientific knowledge has so developed in the past 25 or 30 years that it is impossible for one to keep himself posted with uptodate knowledge and in the pressure of executive work which they have undertaken they may not have time to so post themselves. Therefore the younger ones who returned recently with that knowledge must be drawn closer more and more.

I was told that in Japan when once the Japanese imported a machinery from abroad, he would not once again rush to the same source for further indents. They produce both the parts which are necessary and also produce the whole machine. Possibly this may involve in some cases some violation of those regulations of International patents and designs. You must be able to produce the parts, etc. and every attempt must be made in that direction.

A spirit must grow in the minds of all engineers that they should become machine minded in their own line and in the colleges themselves more of practical work should be taught to the engineers than at present. The students must work at least half the time in a factory and side by side the other half time devoted to their theory. That I learn is the system prevailing in America. The American engineers do not seem to be absolutely depending on others for their work. They know how to handle the machines themselves and work them even if the foremen or the workmen should fail to cooperate. That kind of machine mindedness is necessary even during college courses.

I am speaking with personal knowledge that many of the students of the college and even those that have passed out, cannot handle the machine. Such a kind of divorce between theory and practice is not in the best interests of the country. This has to be remedied as early as possible. There is no dearth of industries now and the occasion for their use and the opportunities are available for the youngmen to work on the machine and to obtain a direct knowledge thereof. Such opportunities should be fully utilised.

I am not in favour of an engineer merely passing an examination and qualifying himself as an engineer. I trust that the M.I.E. examination should be suitably modified and 50% of the marks allotted for practical knowledge in the engineers' course.

Speaking today in the agricultural field with which I started besides fertilizer factories, small implements like plough and others which are mechanically propelled, may be usefully invented and made available at nominal cost. Cattle are becoming highly costly. Even old ploughs are not sufficiently useful. Small tractors are imported from Russia and are sold for Rs. 6,000. We must be able to produce similar ones in our country. I have referred in detail to agricultural machinery and implements for the reason that it is the biggest of the industries and the problem of food is the most pressing one.

A research must also be progressively made to utilise the Indigenous materials and also to economise in the use of raw materials for the manufacture of plant and machinery. In the estimates that are prepared for plant and machinery I found as the Chairman of the Estimates Committee that the original estimates were prepared at a low amount and subsequently the estimates were increased two-fold and three-fold. These are happening in the Public Sector. This ought not to occur. If the Private Sector is given this advice, would it be possible for the private owner to meet the increase in the estimates by more more 10% of the original. The same should apply to the Government also. Your estimates must be absolutely accurate and any deviation should not be more than 10% of the original.

Regarding the plant and machinery for industries as a whole, let us bear in mind that top priority has to be given today to defence industries. As we cannot depend for food on countries outside but should make ourselves self-sufficient in it, so in the defence industries we must make ourselves self-sufficient.

Various considerations come in the supply of materials of the necessary amenities, etc. and instruments from outside. They may be political and economic. Therefore in this regard you have done well to request the Defence Minister to come and inaugurate the Convention. I am sure you will help him and the Government. To render efficient service and help in this direction you must first of all set up a high power committee to decide as to what are the productions that are necessary for the defence, what can be produced here having regard to our raw materials and skill and how the production can be distributed over to several agencies and their efforts coordinated. I am sure you are proceeding on these lines.

Regarding other industries on account of large labour potentials available here, every effort must be made to utilise labour. While rationalisation is constantly going on in foreign countries and economising human labour is attempted at, our plan ought to be to utilise our man power as much as possible and to avoid mechanisation wherever man power can do the business equally well. Otherwise unemployment will become a serious problem. Labour saving devices are no doubt good but there is no one rule for this in all countries. The social and economic situation must also be taken into consideration.

In our country it is necessary to divide industries into convenient groups and it has so been divided already such as cottage and village industries, medium and small scale industries and large scale industries In the field of cottage industries, until the machine age came in, ours was the foremost country in the world in their production. Even now it stands next to none in that field in fineness, finish and quality but we can produce cottage products a little more quickly by the use of machines. Please therefore set up a committee to help production in larger quantities so as to ensure better income for the handicraft producers.

For medium size and small scale industries, there is great scope in our country. This is the field in which larger number of people can be utilised. In Ludhiana there are as many as 1,300 units of various varieties producing some form of materials, some kinds of goods or the other. That whole town is industry minded.

In the State of Bihar, we are rich in minerals in the South Bihar and we are rich in water supply in the north. For want of dams across the rivers the north is flooded and for want of small scale industries to utilise the minerals, the beneficiaries are the big businessmen from Calcutta and Bombay. Small scale industries must be set up and cheap machines must be devised for the purpose providing employment to them. I am glad to find in the morning papers that Poland has placed orders for a number of our HMT engines.

Even with respect to large scale and heavy industries it is necessary to standardise the parts and distribute their production over convenient groups so as to provide employment for a larger number of people. This I noticed in Japan. For want of standardisation it is not possible to spread the production in this country. Every attempt ought to be made to spread employment and to man them by such decentralized manufacture.

Even in the matter of building materials, much economy is possible. Much materials could easily be saved. A short time ago an agent of some German Company came here and tried to demonstrate how lighter trusses can be utilised to support the same construction for which heavier ones are being used today. No amount of research in this direction is too much.

There is much work to be done. The world is watching us. Notwithstanding our population, our ancient culture, our love of peace and all the human virtues that we have developed, we are still not recognized as one of the biggest countries in the world for the reason that we are not rich. Riches depend upon industrialisation. We have not developed sputniks and nuclear weapons. These are the norms of social values in the international world today. I do not want countrymen to imitate the others and to substitute our social values by adopting theirs. Our social values have always depended on service and sacrifice but it does not mean that we should be groaning under eternal poverty when we can easily tide over it and bring about a happy and comfortable living. We are not living to eat but *we must eat to live.* To meet at least the minimum standards, we must work laboriously and make our country industrialised and also improve our agriculture. Machine is the one which will increase the production in both the fields. This is the age of science and technology. You are therefore the builders of the present India. Please work with that consciousness and a missionary zeal, so as to enable the country to produce more and share the profits.

Lastly, with regard to the management of the big industrials, I would prefer an engineer to be the Manager to a simple administrator. This I found both in Russia and in Eastern Europe. Industrial policy resolution has declared that an industrial and commercial service should be developed in this country to man the industries. Likewise an All-India Engineering Service must be set up to man the several engineering projects. I am glad that a central act has been passed in this regard.

I hope and trust that you will establish standing committees to study the problems from time to time all the year round and offer solutions for them to the Government and to the private industries also when necessary. There ought to be no antipathy between private and public industries in our country. It will take a long time for the private sector alone to meet the growing demands of the country. Each can work fully within its own sphere whether it be a private or public industry. Technical skill is necessary and you are the repositories of such skill. Let your resolutions be practical to tackle current problems and also evolve long range solutions for the problems ahead.

I wish the Convention every success.'

9. Shri S. N. Sinha, Retiring Chairman of the Bihar Centre, then proposed a vote of thanks to the Chief Guest, Shri Chavan, and the other guests present as follows:

'Shri Rajyapal, Union Defence Minister, Shri Chavan, Ladies and Gentlemen,

It is now my proud privilege to express our sincere thanks for your presence in our midst this morning.

Words would fail to express our gratitude, specially to you, Sir, in spite of your very heavy pre-occupations as the nation's Defence Minister, could find time to grace this occasion. It will certainly encourage and enthuse us greatly in our subsequent deliberations. We are also very thankful to you, Sir, for your words of appreciation and on our behalf we can assure you that we would continue to apply ourselves to the task with devotion and with country's welfare uppermost in our mind.

As a matter of fact, Sir, we could do very much better but for the circumstances in which the engineer has to work. The professional or technical head of the Department can give his best to the Government and thus to the nation, only, if he is in direct contact with the nominee of the people, *i.e.*, the Minister-in-charge. As Defence Minister, guiding varieties of experts including engineers and defence personnel, you are, Sir, in a much better position to appreciate this. The inter-position of a non-technical administrator, between the minister and the technical head of the department prevents proper synthesis of professional advice of which the technical head is the master and the public welfare and national policy of which the minister is the custodian.

Today, in general, the engineer is not only burdened to think, plan, invent and execute, but ironically enough, he has to take the additional responsibility of getting others to agree to his view point—in a way, canvass a technical decision on the matter. The pure scientist is a searcher, continually probing beyond the frontiers of knowledge. In his search he makes discoveries ; he goes on searching. But the task of an engineer is different and hence difficult. He has to turn to science into application and put it to practical use, and in this he naturally becomes involved with others to ensure the 'execution of works' to take place.

Responsibility without authority, therefore, leads to waste and lack of proper utilization of our efforts and talents which in turn effects 'Our India of tomorrow'. This is why we are compelled to speak of it time and again.

Perhaps, it is necessary to draw lessons from history. Ancient China and Greece and Rome in turn paid the price of treating Engineering as of secondary importance and lost their leadership in the world of their days. As the Greek said, 'Even God do not fight against necessity', and Engineering is a necessity.

As far as we are concerned, Sir, we continue to work with sense of service and sacrifice. We follow Lord Krishna's advice in Geeta:
'To work is our right, for the result it is not', though the limitation referred to, in this case, is destiny's hand and not human.

I once again, extend, on my behalf and on behalf of the President, Council Members and members of the Institution, grateful thanks to you, Sir, our most honoured and valued guest for your gracious presence. I also most sincerely thank you, ladies and gentlemen for having added to our pleasures and success by your presence.

Thank you all very much indeed.'

The Session concluded at 1.30 p.m. with the singing of the National Anthem.

Closing Session, Thursday, February 3, 1966

The Closing Session was held at 12.00 noon on February 3, 1966, in the Bihar College of Engineering, Patna. The President, Shri B. P. Kapadia, was in the Chair.

Commencing the proceedings, the President said that he would request the Convenor of the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan', the members who took the Chairs at the meetings of the various Divisions and Groups, and also at the Students' Session held during the Convention, to give brief reports of the proceedings in the respective sessions.

(i) Brig. M. K. Rao (*M.*), Convenor of the Seminar on 'The Role of the Engineer in the Fourth Five Year Plan, said that the Seminar which was inaugurated on January 30, 1966, by Shri K. B. Sahay, the Chief Minister of Bihar, was held in different sessions, each of which was devoted to discussions on specific topics.

The session on 'Communications' was held on January 30, 1966, between 12 noon and 1 p.m. Prof. M. V. Deshpande (*M.*) took the Chair and Lt.-Col. S. Mishra (*M.*) was the General Reporter for the session.

The session on 'Organization' was held on January 30, 1966, between 5 p.m. and 6 p.m. Maj-Gen. Harkirat Singh, Past-President, took the Chair and Prof. A. Lakshmanaswamy (*M.*) was the General Reporter for the session.

The session on 'Resources and Miscellaneous' was held on January 31, 1966, between 2.30 p.m. and 4.30 p.m. Brig. S. K. Bose (*M.*) took the Chair and Dr. H. C. Visvesvaraya (*M.*) was the General Reporter for the session.

The session on 'Management and Productivity' was held on February 1, 1966, between 9 a.m. and 11.30 a.m. Shri T. R. Gupta (*M.*) took the Chair and Shri B. V. Raman (*M.*) was the General Reporter for the session.

The session on 'Development Projects' was held on February 1, 1966, between 10 a.m. and 12 noon. Shri K. F. Antia (*M.*) took the Chair and Shri J. G. Bodhe (*M.*) was the General Reporter for the session.

The session on 'Irrigation and Power' was held on February 1, 1966, between 11 a.m. and 1 p.m. Prof. H. C. Guha (*M.*) took the Chair and Dr. A. Bhattacharya (*M.*) was the General Reporter for the session.

The session on 'Agriculture' was held on February 1, 1966, between 2.30 p.m. and 3.30 p.m. Maj.-Gen. S. P. Vohra (*M.*) took the Chair and Dr. N. S. Nandeeswaraiya (*M.*) was the General Reporter for the session.

The concluding session of the Seminar took place on February 1, 1966, between 3.30 p.m. and 4.30 p.m. Brig. M. K. Rao (*M.*), Convenor, took the Chair and presented the review of the lively discussions in the different sessions.

The President then proposed a Vote of Thanks to Brig. M. K. Rao for the success of the Seminar. (*Applause*).

(ii) Shri K. K. Nambiar (*M.*), Chairman of the Civil Engineering Division, who took the Chair during the Paper Meetings in the Division, said that the meetings took place between 12 noon to 1 p.m. and 2.30 p.m. to 4 p.m. on February 1, 1966, and also between 11 a.m. to 1 p.m. and 2.30 p.m. to 4.30 p.m. on February 2, 1966. The proceedings started with the Chairman's Address covering the broad aspects of the civil engineering profession today.

Out of the eight papers belonging to the subjects 'hydraulics and irrigation', 'structural', 'bridges and roads', 'foundation engineering' and 'miscellaneous', only five papers were presented by the respective authors. Lively discussions took place on the two papers pertaining to 'hydraulics and irrigation'. Considerable interest was also shown by the discussers in the two papers pertaining to the subject 'structural', and in the only paper grouped under 'miscellaneous'.

The President then proposed a Vote of Thanks to Shri K. K. Nambiar (*M.*) for the success of the technical meetings in the Civil Engineering Division. (*Applause*).

(iii) Prof. H. C. Guha (*M.*), Chairman of the Electrical Engineering Division, who took the Chair during the paper meetings of the Division, said that the meetings took place between 11 a.m. to 1 p.m., and 2.30 p.m. to 4.30 p.m. on February 2, 1966. The proceedings commenced with the Chairman's Address in which a brief review of the problems relating to optimization of power system economy was presented with special reference to the combined operation of steam and hydro power plant and the operation of interconnected power systems, and the need for long-range optimum programming of electric power systems was stressed. The Chairman also observed that the need for effecting strict economy in the execution of capital projects and in the operation of plants is supreme in the present context of the country's planning.

In the paper meetings, lively discussion took place on the presentation of four papers by the respective authors. However, due to the absence of several authors, all the fifteen papers selected for the paper meetings could not be taken up for discussion.

The President then proposed a Vote of Thanks to Prof. H. C. Guha (*M.*) for the successful conduct of the technical meetings in the Electrical Engineering Division. (*Applause*).

(iv) Maj.-Gen. S. P. Vohra (*M.*), who took the Chair in the Paper Meetings in the Mechanical Engineering Division, said that the meetings took place between 12 noon to 1 p.m., and 2.30 p.m. to 4 p.m. on February 1, 1966.

The proceedings started with the Chairman's Address in which the basic requirements of a paper for publication in the Institution Journal were discussed. In the paper meetings, which followed, seven papers were presented by the respective authors and lively discussions were held by the attending members.

A 'Refresher Seminar' on 'Modern Techniques of Production Control and Management' was held under the Division on February 2, 1966, between 11 a.m. to 1 p.m. and 2.30 p.m. to 4.30 p.m. Shri S. Padhi (*M.*) took the Chair. Five papers were presented by the respective authors, dealing with the various aspects of management and production control techniques.

The President then proposed a Vote of Thanks to Maj.-Gen. S. P. Vohra (*M.*) for the success of the technical meetings in the Mechanical Engineering Division. (*Applause*).

(v) Brig. M. K. Rao (*M.*), Chairman of the Electronics and Telecommunication Engineering Division, who took the Chair in the paper meetings of the Division said that the meetings were held between 11.00 a.m. to 1.00 p.m. and 2.30 p.m. to 4.30 p.m., on February 2, 1966, and the proceedings commenced with the Chairman's Address, in which the various aspects of satellite communication were dealt with. The authors of four technical papers presented the highlights of their findings and discussions followed. The meeting of the Automatic Control Group was also conducted simultaneously and the Chairman's Address was read in the Group meeting.

The President then proposed a Vote of Thanks to Brig. M. K. Rao (*M.*) for the success of the technical meetings in the Electronics and Telecommunication Engineering Division. (*Applause*).

(vi) Shri K. N. Rohatgi (*M.*) presented the report on behalf of Shri S. K. Majumder (*M.*), the retiring Chairman of the Public Health Engineering Division, who took the chair during the paper meetings of the Division. Shri Rohatgi said that the paper meeting of the Division was held on February 1, 1966, between 12.00 noon to 1.00 p.m. and 2.30 p.m. to 4.00 p.m. The proceedings commenced with the Chairman's Address which dealt with the outlines of the problems of public health engineering in the country today. In the absence of the authors of the technical papers, members participating in the meeting presented the papers scheduled for discussion and many engineers took active part in the discussions which followed.

The President then proposed a Vote of Thanks to Shri K. N. Rohatgi (*M.*), and desired that a Vote of Thanks be conveyed to Shri S. K. Majumder (*M.*) for the success of technical paper meeting in the Division. (*Applause*).

(vii) Shri S. K. Mukherjee (*A.M.*) who took the Chair in the Paper Meetings of the Chemical Engineering Division, said that the meeting was held on February 1, 1966, between 12.00 noon to 1.00 p.m. and 2.30 p.m. to 4.30 p.m. The proceedings commenced with his Address in which the problems of the Division were generally outlined. The presentation of the papers by the authors then followed and the attending members participated in the discussion.

The President then proposed a Vote of Thanks to Shri S. K. Mukherjee (*M.*) for the success of the paper meeting in the Division. (*Applause*).

(viii) Dr. G. P. Chatterjee (*M.*), Chairman of the Mining and Metallurgy Division, who took the Chair during the paper meeting, said that the meeting took place on February 2, 1966, between 11.00 a.m. to 1.00 p.m. and 2.30 p.m. to 4.30 p.m. The proceedings started with the Chairman's Address which was followed by a brief address by the President who also attended the meeting. In his brief address the President requested the members present and also the Chairman of the Division to try to increase the strength of membership attached to this Division and devote sometime for increasing its popularity and widening the sphere of the activities. The technical papers scheduled for discussion were then presented by the respective authors and discussions followed.

In the absence of Dr. A. Lahiri (*M.*), Chairman, Petroleum Engineering Group, the paper meeting of the Group was also taken up in the meeting of the Division. The Deputy Director, Fuel Research Institute, Dhanbad, presented the Group Chairman's Address.

The President then proposed a Vote of Thanks to Dr. G. P. Chatterjee (*M.*) for the success of the technical meetings in his Division. (*Applause*).

(ix) In the absence of Shri D. N. Chopra (*M.*), Chairman of the Railway Engineering Group, who took the Chair during the paper meeting of the Group, Shri D. K. Ghosh, Deputy Secretary, presented the report. He said that the paper meeting of the Railway Engineering Group took place between 12.00 noon to 1.00 p.m. and 2.30 p.m. to 4.00 p.m. on February 1, 1966. The proceedings commenced with the Chairman's Address which dealt with the present day activities in the sphere of railway engineering in the country. The technical papers scheduled for discussion were then presented by the respective authors and lively discussion followed.

The President then proposed a Vote of Thanks to Shri D. N. Chopra (*M.*) (*in absentia*) for the success of the technical meeting in his Group and directed it to be conveyed to Shri Chopra subsequently. (*Applause*).

(x) Shri K. F. Antia, Chairman of the Prestressed Concrete Group, who took the Chair during the paper meeting said that the meeting was held on February 1, 1966, between 12.00 noon to 1.00 p.m. and 2.30 p.m. to 4.00 p.m. Seven papers had been received and six approved for publication. As none of the authors were present, and the subjects of the papers did not bring out any outstanding features in prestressed concrete, pertinent technical and other problems were proposed for discussion by participating members.

The unfortunate position of economic designs in prestressed concrete having to be set aside for other less economic designs due to a comparatively small amount of foreign exchange not being sanctioned was brought out.

The various systems of prestressing in use in India were discussed. Mention was made of a simple improvised method of cold working of wires developed in the Central Building Research Station at Roorkee.

The possibilities of prestressed concrete through girders for heavy railway loading were indicated. Spans of 40 to 60 and even 80 feet deck girders have been extensively used but longr spans for such heavy loading are still to be introduced although spans well over 150 feet are common in road bridges in India.

The subject of increasing use of prestressed precast concrete was discussed extensively. The most important criteria for successful application were considered to be .1 substantial loads and large spans to make prestressed concrete more economical than reinforced concrete and .2 restriction within a certain radius from the manufacturing centre due to the impact of transport cost. Reference was made to the Thaker Committee report wherein prefabrication of large units was not considered currently applicable in India. It was explained that this referred to very large precast units such as complete rooms for which heavy handling equipment was necessary.

The feasibility of precasting of large number of units or units of large size at construction site were discussed and recommended where economically feasible.

The Chairman referred to the forthcoming four yearly conference of the Federation International de la Precontrainte in France and a brochure from the Indian National body which was under preparation. He also indicated the work of the International Commissions such as that on Lightweight Prestressed Concrete on which India was represented.

The President then proposed a Vote of Thanks to Shri K. F. Antia (*M.*) for the success of the technical meetings in his Group. (*Applause*).

(xi) In the absence of Prof. G. S. Ramaswamy (*M.*), Chairman of the Shell Structures Group, who took the Chair during the paper meeting, Shri N. M. Thadani (*M.*) presented the report. He said that the paper meeting took place on February 1, 1966, between 12.00 noon to 1.00 p.m. and 2.30 p.m. to 4.30 p.m. The Chairman in his address highlighted some of the recent advances in this rapidly developing field. He laid special emphasis on the spectacular advances made in the realm of analysis and design with the aid of digital computers. He gave a list of computer programmes developed by the Structural Engineering Research Centre and called on practising engineers to make good use of them and save themselves the drudgery of large and tedious calculations involved in the analysis of shells by monual meous. He also referred to the reappraisal that is taking place in methods of analysis. The effort today is to find methods such as the matrix methods, which are specially suitable for use on the computer.

Five papers were discussed at the Session. Shri B. K. Chatterjee and the Chairman gave descriptions of some of the recent shell structures built in India. They illustrated their accounts with slides.

In response to an appeal made by the Chairman, Shri B. K. Chatterjee came forward with the generous offer to institute a prize in the name of his firm for the best paper on shell structures published in the *Journal* every year.

The session was well attended and the discussions were very lively and useful.

The President then proposed a Vote of Thanks to Shri N. M. Thadani (*M.*) and directed to convey a Vote of Thanks to Shri G. S. Ramaswamy (*M.*) for the success of the paper meeting in his Group. (*Applause*).

(xii) In the absence of Shri Baleshwar Nath (*M.*) who took the Chair in the paper meeting of the Hindi Section, because Shri Brijmohan Lal (*M.*), Adviser, Hindi Section, could not be present for the Convention, Dr. Janardhan Jha (*A.M.*) presented the report. He said that the paper meeting in Hindi Section was held on February 1, 1966, between 12.00 noon to 1.00 p.m. The proceedings commenced with the Address of Shri Brijmohan Lal (*M.*) which was read by Shri Vishwambhar Prasad (*A.M.*). The technical papers scheduled for discussion were then presented by the respective authors and lively discussion followed. Thereafter Dr. G. P. Chatterjee (*M.*) delivered a brief and interesting talk on 'The Equipment of the Research and Control Laboratory of the Durgapur Steel Plant which have been installed in India for the first time'.

The President then proposed a Vote of Thanks to Dr. Janardhan Jha (*A.M.*) and directed to convey a Vote of Thanks to Sarvashri Baleshwar Nath (*M.*) and Brijmohan Lal (*M.*) for the success of the technical paper meeting in the Section.

(xiii) Lt.-Col. R. S. Attre (*M.*) who took the Chair in the Students' Session (General and Technical) said that the sessions were held on February 1, 1966, between 4.30 p.m. and 8.30 p.m. This was considerably in excess of the scheduled time of only two hours allocated for the Students' Session in the Convention Programme. The proceedings of the Sessions commenced with the Chairman's Address in which the need for more active participation of the Corporate Members in the Students' activities was stressed.

The Students' Session was conducted in two parts; firstly the Technical Session and secondly the General Session. In the Technical Session, eleven papers were presented by the students. They are of above average standard and were fully discussd by the authors as well as the audience. As declared by the Judges first three papers in order of merit were selected for the award of prizes.

Before commencement of the General Session the President addressed the students and expressd his joy to met them. He stated that he was greatly interested in their problems and difficulties. He also stressed that the Students' Session must be given its due importance and be held in future in the same atmosphere as the Seminars, Paper Meetings, etc. The President also said that he would like to investigate the causes of poor results at the examinations conducted by the Institution. He invited suggestions from the Students as to how our libraries at the various Centres and Sub-Centres should be equipped. The President also advised the Students to keep high integrity and raise up their standard so that they are respected more and more. The President listened to some of the suggestions made by the Students and noted the points submitted by them for his consideration. The Students were very happy that the President attended their Session and remained with them for about two hours in spite of his extreme business and other engagements.

In the General Session, the Students brought out various points, suggestions and grievances which were noted by the Deputy Secretary, Shri D. K. Ghosh. The President directed the Deputy Secretary that replies to the suggestions and points submitted by the Students be intimated to all the Students' Chapter in the country through the respective Local Centres in due course of time.

Lt.-Col. Attre stated that it is very encouraging to note that the activities of the Students are increasing day-by-day and the standard of the papers written by them is well above the average. It is certain that with the necessary guidance and help, the Student members of the Institution will shine much more and be real assets of our Institution.

For the papers read at the Stuents' Session on February 1, 1966, the following prizes were awarded.

(i) The first prize to Shri C. M. Prasad for his paper entitled 'The Scientific and Economic Approach to Highway in Bihar'.

(ii) The second prize to Shri M. C. Garg for his paper entitled 'Modern Airport Lighting'.

(iii) The third prize to Shri K. S. Mallappa for his paper entitled 'Plant Engineering in an Industry'.

The prizes were awarded by Shri B. P. Kapadia, President. The recipients who were present for receiving the prizes are Sarvashri C. M. Prasad and K. S. Mallappa.

The President proposed a Vote of Thanks to Lt.-Col. R. S. Attre (*M.*) for the successful conduct of the General and Technical Sessions of the Students' Session during the Convention. (*Applause*).

The President, Shri B. P. Kapadia (*M.*) then concluded as follows:

'I have now a very pleasant duty of extending our warm thanks to the Bihar Centre for acting as hosts on the occasion of the 46th Annual Convention and for their hospitality during the last few days. Our appreciation has to be given in a double measure particularly as the arrangements have been very elaborate and thorough. I also understand that the registration of engineers from all over the country has been rather high. I wish particularly to mention the names of Shri R. L. Singh Yadav, Minister of Public Works and Chairman of the Reception Committee, Shri S. N. Sinha, Retiring Chairman of the Bihar Centre, who invited us to Patna for the Convention, Shri K. N. Rohatgi, Honorary Secretary, and Shri N. N. Rohatgi, the Organising Secretary. The work of organising the Convention was carried on under the inspiration and personal guidance of Shri Sinha ably supported by the senior and the junior Rohatgi. Our thanks are also due to the members of the Steering Committee and the Executive Committee, the various Convention Sub-Committees and the Staff of the Bihar Centre who are responsible for the various arrangements to make the Convention a success. I must also thank the officers and staff of the Institution Headquarters for their hard work and cooperation.

Our special thanks should be given to the Convenor and the members of the Ladies Committee of the Bihar Centre who have so kindly and generously looked after the visiting ladies, shown them round this beautiful city, taken them to the shopping centres and otherwise entertained them. I wish to particularly express the thanks of the Institution to His Excellency the Governor of Bihar, Shri K. B. Sahay, Chief Minister of Bihar, Shri S. N. Sinha, Education Minister of Bihar, and Shri B. C. Patel, Revenue Minister of Bihar. Our sincere thanks are extended to the Chief Engineer, P.W.D. (R&B), and his staff, the Chief Engineer, Ganga Bridge Project, and his staff, the Chief Engineer (Civil) of the Bihar State Electricity Board, the Chief Engineer (Rural Cell and Community Development), the Chief Engineer, Electricity Department of the State Government, the Divisional Superintendent, Eastern Railway, Dinapore, Shri Bhaskaran, Divisional

Engineer, Telephones, the Bihar State Road Transport Corporation, the authorities of the Rabindra Bhawan, the Principal, Bihar Veterinary College, the Commandant, Bihar Military Police, Phulwari Sharif.

I also thank the Postmaster-General and the Superintendent of the Divisional Office and his staff for opening a temporary post office, the Director of Health Service for opening First Aid posts, the Patna Police authorities and their staff for the assistance in regulating traffic and constant vigilance during the Convention period.

I have also to thank Messrs. Rohtas Industries, Messrs. United Provinces Commercial Corporation Ltd., and Messrs. Arvind Bros. Private Ltd., who have arranged our lunches in the previous days, and Messrs. VIBGYOR who are arranging our lunch today, and Messrs. Pradip Lamp Works and Messrs. Reliable Water Supply Specialists of India Private Ltd., for arranging Tea and At Home, and also the representatives of the various newspapers who have reflected the views of the engineers, expressed during the Convention, all over the country. I also thank the members responsible for arranging the Variety Entertainments during the past few days.

I must also express grateful thanks to the Government of Bihar for all the facilities they have so readily extended to the Bihar Centre of the Institution which primarily made it possible to make all the extensive arrangements for such a large scale Convention. I am sure you have enjoyed the various Variety Entertainments organised in aid of the National Defence Fund and the number of local and outstation visits.

Today the outstation tours for the delegates will be commencing and I take this opportunity to extend my sincere thanks to the Railway Authorities and our friends in other organisations at Ranchi, Nalanda, Rajgir, Dhanbad, Jamshedpur, Bodh Gaya and Dehri-on-Sone, with whose help and enterprise, I am sure, the delegates will have the glimpses of the present day as well as the historical Bihar.

Last but not the least I would like to express my thanks to the Vice-Chancellor, Patna University, and the Principal, Bihar College of Engineering and his staff for the excellent cooperation and assistance in the past few days which have contributed much to the success of the Convention.

I must add a word of appreciation for our Past-Secretary, Shri B. Seshadri, who has left us as well as the country, and record that his sincerity and devotion to the service of the Institution is well remembered on this occasion by all the members present here'. (*Applause*).

Shri S. N. Sinha (*M.*), thanking all those who helped to make the Convention a success, said:

'I feel overwhelmed by the appreciation and sentiments expressed by our President on behalf of our guests in regard to the arrangements made for this Convention at Patna by the Bihar Centre; the more so as I am quite conscious of our failings and inadequacy of the arrangements in many respects. Still I would like to assure you that whatever inconveniences were caused to any of you was not due to any lack of will on our part, but only due to our limitations under the courses of circumstances. To our President, Shri Kapadia, I am particularly grateful for the guidance and encouragement given to all of us during the Convention. I hope those who are participating in the outstation tours will find them useful as well as enjoyable.

I wish you all a comfortable return journey and thank you once again.'

Social and other functions

Annual Dinner

The Forty-Sixth Annual Dinner of the Institution was held on Wednesday, February 2, 1966, in the grounds of the Bihar College of Engineering, Patna. Shri R. L. Singh Yadav, Minister of Public Works Department, was the Chief Guest. Many guests and over 150 members attended the Dinner.

After the Dinner, the President, Shri B. P. Kapadia, requested the guests and members to rise and drink a Toast to the President and the Republic of India.

The President, Shri Kapadia, also proposed a Toast to the Chief Guest, Shri Yadav replied to the Toast.

Dr. (Mrs.) Rohatgi proposed a Toast to 'Our Guests'.

Shri K. K. Nambiar replied to the Toast.

Tea by Pradip Lamp Works

Pradip Lamp Works, Patna, gave tea to the delegates in the compound of Sir Sultan Palace on the evening of Sunday, January 30, 1966.

Talk by Shri J. G. Bodhe

A talk on 'Bio-Engineering' was delivered by Shri J. G. Bodhe at Rabindra Bhavan on January 30, 1966.

Lunch by V. Poddar

Shri V. Poddar, Works Manager, Rohtas Industries, gave a lunch to the delegates in the grounds of the Bihar College of Engineering on January 31, 1966.

'At-Home' by the Minister of P.W.D.

Shri R. L. Singh Yadav, Minister of Public Works Department, Bihar, gave an 'At-Home' to the delegates at the State Guest House, on January 31, 1966.

Variety Entertainment

A Variety Entertainment in aid of the National Defence Fund was arranged at Rabindra Bhawan on January 31, 1966.

Lunch by United Provinces Commercial Corporation

The United Provinces Commercial Corporation gave a lunch to the delegates in the grounds of the Bihar College of Engineering on February 1, 1966.

'At Home' by Sahu Cement

Another 'At Home' was given to the delegates by Sahu Cement on February 1, 1966, in the grounds of the Bihar College of Engineering.

Variety Entertainment

Another Variety Entertainment was arranged by the Bihar Centre for the entertainment of the delegates at the Rabindra Bhawan on February 1, 1966.

Students' Session

The Students' Session was held on the evening of February 1, 1966, at the Bihar College of Engineering. About 70 students and other members attended. Lt.-Col. R. S. Attre (*M.*), Chairman, Andhra Pradesh Centre, was in the Chair. The President attended the Session and invited Student members to come forward and mention about any hardship or difficulty in the prosecution of their studies or examinations. A large number responded to this. There was great enthusiasm amongst the Student members for the keen interest shown by the President in their welfare.

Lunch by Thakur Prasad

Another lunch was given by Shri Thakur Prasad of Arvind Bros., to the delegates on February 2, 1966.

'At-Home' by Reliable Water Supply Service

One more 'At Home' was given by Reliable Water Supply Service at the grounds of the Bihar College of Engineering on February 2, 1966.

Lunch by VIBGYOR

Another lunch was given by VIBGYOR at the grounds of the Bihar College of Engineering on February 3, 1966.

Local Visits

A number of Local Visits were arranged by the Bihar Centre and the delegates were taken round to see the famous historic places of Patna.

Study Tours

Four Study Tours were arranged at the Conclusion of the Session. They are

Tour 1: Patna-Dhanbad-Jamshedpur

Tour 2: Patna-Ranchi-Jamshedpur

Tour 3: Patna-Nalanda-Rajgir-Bodh Gaya-Dehri-on-Sone

Tour 4: Patna-Baraũni

A special tour for delegates not participating in the above tours was also arranged on February 1, 1966. This tour to Rajgir and Nalanda was ended on the next day.

At the conclusion of the outstation tours on February 6, 1966, the delegates dispersed for their respective home stations.

The Editor regrets that due to non-receipt of photographs taken during the Convention, these could not be incorporated in this issue of the *Bulletin*. The photographs will be published in the next issue, if available.

SHRI B. P. KAPADIA, M.I.E.
PRESIDENT, SESSION 1966-67

Honourable Shri Yeshwant Rao Chavan, Honourable Ministers of Bihar State, Ladies and Gentlemen,

Before I begin my Address, I have to refer to the greatest tragedy in India that occurred in the twinkling of an eye on the 10th night—I mean the passing away of our beloved great Prime Minister, Shri Lal Bahadur Shastri; according to him, he had done his task and left us all to continue his good work. I fully associate myself with the sentiments expressed by my colleague. May his soul rest in Peace.

On behalf of the Institution of Engineers (India), I am grateful to you, Sir, for accepting our invitation to inaugurate this Convention in spite of the heavy demands on your time and attention. My thanks and pleasure are twofold, as I have the honour and pleasure of welcoming you from our State of Maharashtra, whom we liken to Chhatrapati SHIVAJI, on this occasion. We appreciate it more as we know, Sir, that you have the great task of defending our country in the present crisis. I also welcome the Ministers of this State and other distinguished guests and the members of the Institution, many of whom have come from over long distances.

I am greatly indebted to the members of the Institution Council for conferring on me the honour of being the President for the ensuing year and I shall do my best to be worthy of their choice.

It is a fashion on such occasions to criticise the authorities on every kind of subject and give sermons to the Government, without a mention of one's own poor performance and acts of omission and commission. Ladies and Gentlemen, if you are expecting me to provide excitement of that nature, I shall have to disappoint you. I shall have to refer to public administration in connection with certain matters, but shall do so with moderation.

Sir, you have all the information about our Institution in the brochures, we have given to you, but as you would need a great deal of time to peruse them, I shall briefly refer to a few outstanding facts of the Institution. The Institution was first inaugurated at Calcutta in February 1921. It was granted a Royal Charter in 1935 and it was the first Royal Charter given to a professional body which had its origin and functions in India. It has grown tremendously since and more particularly in the later years and today it has, on its Roll, over 56,000 members of whom the Students number over 40,000. It is one of the few Institutions of its kind in the world and the only one of such a size, and has members from all the engineering faculties, *e.g.*, Civil, Mechanical, Electrical, Mining and Metallurgy, Chemical, Electronics and Telecommunication, Railway, Public Health and others, under one roof. It has 18 Local Centres and 14 Sub-Centres. The Institution is managed and governed by a Council elected by the members of the Institution representing all engineering faculties and all the States of the Indian Union.

In short, it has become a temple of engineering which emanates from its portals knowledge on all engineering subjects. Ours is an Institution of which the country may be proud of. I am glad to say that our Government has not been slow in recognising the importance and the usefulness of the Institution; your very presence here in this morning substantiates my statement.

If an Englishman who left India in 1947 were to visit our country now, I wonder if he would recognise the new India with its immense changes in industrial expansion, education, irrigation, power and defence supply and indeed producing every item of need of the country. Perhaps he may feel ashamed that his compatriots as rulers could not achieve in 200 years what we have accomplished in 18 years in the three successive Five Year Plans. In all these nation-building activities, our engineers have played their part very well; but now they will be severely put to trial in implementing the Fourth Five Year Plan.

Defence

Coming to the engineering subjects in the order of importance, the main task of the engineers today should be to defend our country and play their full part by supplying the requisite manpower, carrying out defence research, making designs, manufacturing defence equipment, building roads, bridges and aerodromes in the quickest possible time, without depending upon foreign countries for aid.

In the beginning there were many resignations from the recruited engineers but by proper screening and very hard training and suitable tests, they have withstood the rigours of climate and undergone every hardship for the defence of their country. Many of our engineers have joined the various units of the Technical Corps of the Army, and also worked behind the scenes in the ammunition factories and workshops which have contributed none the less in the achievement of our victories. They have sacrificed their lives so that others may live. On behalf of the members of the Institution, may I give an undertaking that whatever services and sacrifices you shall demand, we, the engineers, shall not fail to give them under any circumstances.

General Patton's soul must be turning in his grave at the present time as he must have come to know by now that there is a *bazar* of his broken down tanks, a creation of his genius which were considered invincible, till by the skill and bravery of our able officers and brave *jawans*, they came to grief like toys. This has given not only a surprise but a severe shock to the Western countries. Our engineers have built roads and bridges at high altitudes; they were always at the front line and have paid a heavy price.

The only way to make our country self-sufficient in arms is to associate private enterprise in the manufacture of Defence equipment. In this context, I would appeal to you to not merely follow the advice of professional military advisers on the grounds of 'secrecy' and so on. Take courage in your own hands and do this and I have no doubt about its results. If you invite private enterprise to associate with you, do not treat them as outcastes or black-marketeers, but as your equal partners in the defence of our country.

I must congratulate the Defence Minister for giving facilities to the military engineers to attend our Seminar and help the Institution in its deliberations. Such an encouragement is necessary from the other Government Departments and private enterprises also. A large number of military engineers, both junior and senior, are joining the Institution every year and I take this opportunity to express our thanks for their contribution to the affairs of the Institution.

Food

Coming to the item next in importance, which is also the crying need of the day, namely, Food, I believe that the Third Five Year Plan which is expected to be completed soon, has been dis-organised and truncated due to the National Emergency and we shall have to make up the considerable shortfall before attending to the Fourth Five Year Plan. It is heartening to know that in the Fourth Five Year Plan the greatest emphasis is laid on agriculture. It is a well-known fact that most advanced countries in the world owe their prosperity and rise to agriculture. The U.S A. and the U.S.S.R. are the biggest agricultural countries and it is the agriculturists who hold the power of foreign policies and guide the destinies of their nations. In our land too, as one of the greatest agricultural countries, it should be in the fitness of things that agriculture and land use be scientifically developed. This item of our Plan programmes should be put on a 'war footing'; just as the whole of India witnessed during the Emergency, when there was a tremendous enthusiasm in every part of the country and our *jawans* felt proud to fight and give their lives for their country. I regret to say, however, there is no such national feeling and realisation regarding the vital necessities of life and unless we achieve the target of self-sufficiency in food production, all other industrial and power plans will not have much value. No nation can fight or produce anything with empty stomachs.

Land reclamation projects, land and soil conservation schemes, maintenance of old irrigation works and canals, sinking of more tube-wells, re-vitalisation of the filled-up tanks and such other minor works all over the country, if properly carried out, will increase the production of food considerably. It is no use comparing the success in every branch of engineering and technology of the other countries to show how backward we are; instead of that, every engineer should consider that something has got to be done.

I have to observe that as far back as the First Five Year Plan, it was heartening to hear our beloved late Prime Minister, Jawaharlal Nehru, say to the nation that after a couple of years, we shall starve to death but we shall not allow a particle of grain to be imported from the foreign countries.

હમ ભુખે મર જાયેંગે લેકીન એકભી દાણા બહારશે નહિ મંગાયેંગે

There was an all-round enthusiasm created by his dynamic personality: all possible land was cultivated and food production had increased; but later on, as is usual with our people, the tempo of enthusiasm dwindled, and today we are not in the same but a greater difficulty. I am aware of the fact that since that time, our population has increased and that has also contributed to the scarcity of food, but I say forcibly that it is a *normal* thing in the life of India and our planners and engineers *ought* to provide for it.

I submit to this august body that our engineers should at the present time evolve short-term plans without waiting for long-term plans and achieve immediate results in production of food. It is no use blaming the Nature for sending less rain and then cry about food; as far as I know, God has been sending the same amount of rain all these hundreds of years but *in certain cycles* which we have not studied scientifically for want of sufficient records. I feel personally amused to read big headlines in the newspapers about boats plying in the streets of some cities due to so-called excessive rainfall; I have seen this phenomenon during my lifetime so many times from my childhood. There is a proverb amongst us that 'We are used to dig well only after the fire has taken place'. Shall I say that it is better to dig wells now and guard against the second fire than dig no wells at all? How many thousands of miles of rivers are, at all times, flowing with abundant water in all parts of India, irrespective of rain or no rain, and it is up to us, engineers, to tackle these river waters and use them for agriculture. No doubt we have embarked upon and executed in the three Five Year Plans many irrigation projects, minor and major, successfully, and converted vast dry areas into fertile lands, and yet all this is not found sufficient. A simple idea has been given to me for consideration, which will not cost a large capital outlay and that is to supply water for irrigation for half-a-mile of land on either side of the river banks. The idea is to have two barges—one fitted with not very powerful pumps to pump water from these rivers to both the banks as and when required and the second barge to be used for staff and keeping stores. We all know that our farmers are very clever and they do irrigation on either bank of the rivers, wherever the levels permit, by diverting the river water, but there remain huge tracts of land uncultivated.

I know one engineer, who is over 80 years old and is living in a forest in a small hut for the last 10-12 years, propagating and proving successfully his theory that there should be no classification of land as forest land, where only grass and jungle trees can grow. He submits that by providing *bund* and terracing and using every drop of water from the natural sources, every kind of crop can be raised and *famine will disappear.* Provision of *bund* and terracing is an ancestral method, and this may be a fantastic claim. But it is very useful information for the purpose of investigation and may increase agricultural production. I shall see that the Institution helps him.

Such simple ideas are not unworkable and I say that 'Where there is a will, there is a way'. I shall not touch upon fertilizers and so many other matters connected with food, except to observe that more research is needed to produce some substitutes with indigenous materials, even if they are only 50% as effective as the conventional fertilizers

We were fortunate in having a Convention of International Council of Scientific Unions (I.C.S.U.) which was concluded only three weeks ago in New Delhi. They have forcefully recommended the use of scientific methods to raise food output. I have every hope that the recommendations of these expert scientists will be implemented immediately, irrespective of finances involved, to increase food production.

The application of our development strategy to attempt to promote agriculture and heavy industrial expansion simultaneously must be revised *immediately.* The strategic nature of our agricultural tendencies is primarily responsible for our low food production. Rigid and restrictive controls in all matters of economy, including food, can never effect the desired output.

I would like to draw your kind attention to the report of the Study Groups, published a few days ago, which stated that 80% of the necessary technical know-how is available indigenously in the branches of chemicals dyes, power, aircraft, mining, petroleum, paper, textiles, fertilizers, etc. Our engineers should select only a few out of these and become specialists in those, just as the medical men specialise in certain fields only. It is time that the Government realise that the Chief Engineer of a department should not be expected to know all branches of engineering. If he is given the charge of subjects in which he is not qualified, the result shall be obvious. One of the excellent recommendation of the Study Groups is to suggest that 5% of the turnover of all industries should be set apart for research and developing technical know-how.

Education and research

Fortunes are spent in foreign countries on research. Research is the lifeline of any nation; and specially in a developing country like ours, its importance is too well-known to be magnified. No amount of money should be considered sufficient for research equipment. Prospects of economy discovered by research will more than compensate the amount spent on research. The Institution has formed a Research Committee but the task is too gigantic to achieve any practical results by a private voluntary organisation like ours.

Along with agriculture, technical education and engineering research should receive high priority. Our Institution is not lacking behind in recognising the importance of technical education and has taken appropriate steps to fulfil the tasks it has set for itself. It is not a mere accident that since the last two years a number of seats in the Council have been occupied by the Professors of engineering colleges. This is a departure from the past. So the Institution has a ready-made reservoir which can be utilised in spreading technical education. It is time that our engineers, engaged in teaching, come forward to serve as the honorary instructors in technical institutions, both private and public, just as the doctors do honorary service in the hospitals and other private institutions. Under the able Presidentship of Dr. T. Sen and my immediate predecessor, Prof. N. S. Govinda Rao, a Committee on Engineering Education and Research had been appointed; they had held discussions in several meetings and a report has already been submitted to the Education Commission appointed by the Government of India. I have no doubt that it will receive due consideration. More practical technical education should be the keynote of all our education projects. No doubt, during the last 16 years many technical colleges and schools have been started. However, it is a well-known fact that they are not adequately equipped nor supplied with talented teachers.

Consultants

There are a number of firms who have started consulting engineers' practice but I regret to say that they do not receive any encouragement from the Government. Our engineers are unnecessarily blamed that they are not good 'consulting engineers' and they do not know the know-how of the specialised aspects of engineering for which the Government has to seek foreign collaboration and spend a large amount of valuable foreign exchange. May I ask what steps the Government has taken to encourage these rising firms of consultants? Even if we do need foreign consultants, our present approach is totally wrong. The Government directly deals with the foreign consultants and sometimes, but not always, asks them to take an Indian firm of consultants to work along with them. May I submit, Sir, that this is just the reverse of what should be done. If the Government is serious about it, they should first select a firm of Indian consultants, perhaps in rotation. We are all aware that we are not experts and able to give consulting advice on *all* engineering subjects, but even in such a case it is the Indian firm of consultants who should be allowed to select and take the help of foreign consultants of their choice, to teach them technical know-how. The obvious advantage of this method will be that the foreign consultant firms will not be so independent as they are, when appointed by the Government, in carrying out their duties and the training of Indian personnel; but if the Indian firms of consultants appoint them, their bargaining power will be much greater than that of the Government and they will get the best possible economic terms out of them. In doing so, Indian firms will run a competition in appointing them; they will have an upper hand in starting new ventures and they will be able to extract more work from the foreign consultants than the Government by providing them with all kinds of facilities over and above their huge fees.

It is derogatory for Indian engineers to go begging to foreign firms for selecting them as joint consultants in a project and in doing so, naturally, they will not be treated well. If today there is a shortage of Indian consultant experts for giving advice, the fault lies with the Government. What has it done to encourage them ? I submit further, Sir, that in the initial stage, the Indian firms should be *subsidised* liberally and given financial help to enable them to employ adequate numbers of technical personnel. Sir, last year we learnt with great shock and amazement that huge fees were to be paid to foreign consultants for the preparation of mere drawings and designs of the proposed new Steel Plant. It is a sad commentary on the administration that fantastic fees should be so spent, when we are short of foreign exchange, just to get designs and drawings. After having the experience of five large steel plants, during the three Five Year Plans, and after spending large sums for training our personnel in foreign countries and in the execution of the steel plants, should we not have learnt the art of designing the steel plant ? May I say, Sir, that it is not so. We have learnt them but we have not sufficiently recognised; the reason being just what I have stated that in the selection of foreign consultants, the Indian firms have been given no place for the choice. It is not necessary to go far to support this statement except to quote that our pioneers in the very first steel plant, when India was totally ignorant of such technical know-how, the Tatas of Jamshedpur, started in the right manner, appointed their own consultants as *their employees*, and for many years now there is not a single foreigner employed or working in their plant at Jamshedpur, except in some recent expansion contracts.

Similarly, in all subjects of engineering, whether Public Health, Mechanical, Electrical, etc., the Government has only to bring up firms of

Indian consultants to practise their knowledge. If the Government do not do that, who is to do it? If these firms are given encouragement, I am confident that in the next five years there will not be any need for foreign consultants. The Indian engineers did not know the art of laying oil pipelines in the bed of the sea, but the Chairman of the Bombay Port Trust very wisely made a condition in the tender that the foreign firms must take Indian firms as partners, and today, I am glad to say that the Indians have learnt about the laying of pipelines in the sea and we shall not need any foreigners for similar projects in the future.

Engineer-administrators

For several years now, we have been agitating about non-technical men being put at the head of engineering projects. In the previous Conventions, the subject of management of technical projects by the civil administration was forcibly brought out. As very little has been done on these representations, I have no alternative but to repeat the argument put forward by my predecessors, but with even greater force. It is inconceivable that a civil administrator should be considered as a superior human being and better qualified to be at the head of purely technical projects. The result has been that economy, progress and output of the projects suffered by 10-20%. It is true that they are very efficient officers and I may say that they are 'wonderful' as far as civil and other non-technical departments are concerned, but I would certainly say that they cannot be said to be qualified to manage the technical projects. It takes considerable time for the technical officers working under the civilian to make him understand what it is all this about, and they generally have to leave them to it to manage or mis-manage the project. He cannot know which staff is qualified for what job. When he inspects a technical project, it is beyond his capacity to realise whether anything is radically going wrong, leaving aside the theoretical and the scientific aspects of the problems. Our technical forces are the primary weapons with which we have to fight poverty and disease. A technical man loses heart by working under a civil administrator. Unless there is a perfect co-ordination and co-operation between the head and the technical executives, the desired objective cannot be achieved economically or in quick time.

At present there is a great unrest amongst the engineers regarding the downgrading of their status and scaling down of their pay, compared to the other cadres in the civil administration. Sometime ago, there was 'mass' resignation of over a thousand engineers in one State but further action was patriotically postponed due to the Emergency. There are similar petitions and representations in two or three more States. The Government should take a note and be warned of these tendencies before the unrest takes a stronger turn or before the fever spreads to the other States. The Institution believes that their grievances need to be properly investigated and justice done. It is not only the scale of pay that matters so much, but also the status which is downgraded.

Our Five Year Plans were not meant for administration of Law and Order by the civilians. This 120-year old system of rule by the civilians should cease forthwith. It is a wrong conception that the I.C.S. administrators are 'men of steel', because they are really not so. It is a layman's idea to say that as technical men are required in the execution of the projects, they should not be wasted in civil administration. I submit, Sir, that an engineer, by virtue of his training, is a better qualified person to be a Minister of the Union or the State than a politician. When technical problems in public works or projects or plans are put before him, he does not waste time in understanding the problem or has any need to be guided by a civilian, but he comes down to 'brass tacks' and passes proper orders. When I speak of engineers, I do not necessarily mean only the P.W.D. or other Departmental Chief Engineers, but also the engineers from the private enterprise. It is high time, Sir, that the Government take a decision for associating engineers from the *private* sector in the execution and administration of the Government projects. You must move with the times and change the old-fashioned system with a bold and strong hand. The technical decision on any project should not be in the hands of a single I.C.S. or I.A.S. man or a politician. It is gratifying that recently the Government has acknowledged the merits of engineers and appointed one of our eminent engineers as the Minister incharge of Irrigation and Power at the Centre and another as the Governor of a State. Even our simple suggestion of making the Chief Engineers as Secretaries of their Departments is not acted upon except in one State. Our scientists and engineers must be appointed as Secretaries of the Departments as they are more suited for the task than the I.C.S. or I.A.S. person.

Now what is to be done by the engineers to make the Government move in the matter ? There are two remedies that suggest themselves to me : (1) Engineers should form a union of their own and resolve that none of its technical members of top rank shall serve under a civil administrator, if there is a competent and qualified engineer to do that job. I do not suggest that they should all resign and put the country at a loss but they should ask for transfer, leave, etc. ; and (2) Engineers should seek election in the *Lok Sabha* and the *Rajya Sabha*, as these are the only places where complaints receive proper attention, and these *Sabhas* can force the Government to enforce their will and make the necessary changes in the administration by law. I may inform you, Sir, that there is already a move and some of our engineers have resigned and are preparing for seeking election to the *Rajya Sabha* and the *Lok Sabha*. I may inform you and the members of the Institution that I shall support such moves and give them every kind of assistance. To review the work of a highly qualified technical man by a non-technical person is, on the face of it, fantastic and unworkable. It is no consolation to say that it has worked so far, so why not continue ? My reply to that is that you should investigate at what cost to the nation has it worked before expressing an opinion. The main problem is to have an administrative set-up which can deliver the goods and the conclusion is irresistible that the training and education of persons to be recruited to the administrative services must have a core of realistic technical knowledge to be able to do justice to their job.

Whenever the Government has tried the management by engineers from private enterprise, the results have been most encouraging. There is an example existing today where one of our eminent engineers is serving on one-rupee-a-month on a big Heavy Equipment Project. He has brought order out of chaos and his achievement has been outstanding. The key for his success was that he was given full powers and he had not much interference from the Delhi offices.

Unless the private sector engineers are taken in Government offices for consultation or work together with Government engineers, no technical project can be successful in all respects. Many times engineers are rightly criticised that the estimates are revised so many times. I know some of the Chief Engineers who deliberately do this under-estimation with a full knowledge that it has to be revised soon. When I questioned them about their dishonesty in this regard, they promptly replied that if it was correctly estimated, it would never have been passed by the Finance Department. If that is the state of affairs, what can you expect ? It is also true that many of our estimates are made without any proper study—whether it is the cusec. or the calculation on strength of structures or the financial background. May I suggest that our Chief Engineers should be told that after preparing the final estimate, about 15-20% should be added for mere *ignorance* and I am sure the estimates will be about right.

The Government should take advantage of the Institution by entrusting the investigation and consideration of important problems through the Institution's committees which consist of both officials and non-officials. The Government can grant funds to the Institution toward the expenditure of preparing such reports. The Government Chief Engineers usually appreciate the value of reports coming from a representative body like the Institution. The Government engineers in high position should consider it a privilege and an honour to sit by the side of their junior members in committee meetings of the Institution for deliberation on technical matters.

Engineer-contractors

On occasions such as this, the new President speaks more on the subject he is familiar, in which from his own long experience he is considered as an authority, and hence I must express myself at length on the roll of private enterprise and contractual relations in the execution of Five Year Plans. In doing this I may be excused if I have to repeat what I said on this subject in a Seminar at New Delhi. It is suggested and it will be unparliamentary, if I say that the Government can save the middleman's profit by doing away with the ready-made organisation and machinery of contractors' agencies, who can deliver the goods without much trouble. In my 50 years of experience as a civil engineer and a representative of a contractors' firm of capitalists—and as a matter of fact, I am a very practical engineer—I had to come across all kinds of engineers and administrators over and above my huge administrative staff and I am proud to say that I had the art of managing all of them. In doing that I got to know a very good cross-section of humanity and temperaments of all kinds. Many years ago, the profession of contractors was in the hands of a few competent *mistries* employed by some capitalists. When we look at many historic old buildings, we must say that they did their job very well.

It is often forgotten that the profession of contractors has advanced considerably during the last 20 years, and in it today there are all kinds of talents for design and execution. It is these talented and experienced persons who are not usefully employed by the authorities of projects in the public sector or by the employers of works in the private sector. There is no harm done in consulting contractors' engineer before the specifications and drawings are drawn up and detailed plans discussed freely. This, if done well, will ensure that the project that is to be carried out is based on sound economy and good engineering. This is the common procedure in many foreign countries in the case of large projects. Unless the contractors are trusted and taken into confidence, it is always a tug-of-war between the contractors and the employer's engineers, each trying to out-do the other. This results in increased cost of construction.

It cannot be denied that it is so and it will be impossible to carry out large projects without the help of contractors; hence it is high time that this important aspect of the construction industry is kept in the forefront and receives its due place in the planning and execution of the Fourth Five Year Plan.

When we are short of so many things, it will not be prudent for the authorities incharge of projects not to use the services of the trained and skilled personnel of the contractors' organisations for any reasons whatsoever. If there are any shortcomings in these services, they have to be improved and put right, by guiding them correctly and encouraging them. If the contractors can relieve the authorities of most of the anxieties of execution of a project, it is to be always welcomed; those incharge of projects can then devote more time on so many other things they have tc do, on so many problems of design and for the development of the project after its execution. If the Government staff are free to think, they can always apply their minds on how to economise in the design and cut down costs.

The biggest single problem of the construction industry at present is a fair and equitable standard form of contract agreement. The absence of such a standard form of agreement results in disputes and national losses.

The present standard forms of contract are generally based on those which were in vogue before the country became independent. Forms which had been evolved by the ruling power were obviously designed to suit the administrative set-up which prevailed at that time. The contractor was treated as an inferior party and not as an equal. The entire approach in all the conditions of contract was of suspicion and mistrust.

Although the country is now independent, the contract conditions have not been radically altered or modified to suit the present-day concept of a democratic society. The general approach of suspicion and mistrust still continues, and in all public sector works, the conditions of contract continue to be one-sided. Economy in the construction industry can be achieved only by keeping good contractual relations.

It is essential that a contractor is treated as an equal partner in every form of contract and given the respect which is due to him. All the conditions which favour one of the parties must be removed and made equitable. No authority should be given absolute power to take a decision against which there is no appeal. A decision taken by an engineer should be subject to review, where necessary, by the next higher engineer authority or by arbitration and there should be no interference from any non-technical external agency. The approach should be of mutual trust and confidence.

Considerable progress has been made in the formation of a standard form of contract agreement as a result of agitation by the Builders' Association of India for the last 24 years, and it is about to be finalised. Several Government departments have also formed Special Committees for the same purpose. The Builders' Association of India has produced one such document.

The change-over from the present 'bureaucratic' form of contract to those which eliminate one-sided and unworkable conditions may, during the period of transition, cause some difficulties, as it will necessarily involve a change of mental outlook; but the situation will have to be faced with courage and confidence. The conditions which will be brought about thereafter are bound to be satisfactory and will more than justify any initial hurdle which may appear during the process of evolution.

It is very common to see on heavy projects the big books of 100% specifications, rightly named as 'the Bibles' of the project. It is amazing to find that in contract agreement all kinds of labour amenities are to be provided strictly according to Government Labour Laws, which are very prominently absent in Government works. I can quote many instances of colossal waste of money by unnecessary, strict, unworkable and sometimes wrong specifications.

Very often, due to unnecessarily strict and wrong specifications only a few tenderers quote, sometimes none quote at all, with the result that the owners are forced to do the work departmentally which cannot be always economical. Considerable loss occurs on the provision of supervision for lack of trust on the contractor by the employers. For example, if the employers have 12 supervisors, the contractor has to employ another 12 or more to match them, which is entirely wasteful.

The distrust of the contractors is not the only factor that makes the project more expensive, but it may look strange that the distrust of the owners or Government engineers by their superiors is also an equally important factor in the increased cost of the project. Due to this distrust, the Government's or owners' engineers are nowadays very reluctant and afraid to exercise their own independent powers legitimately or properly, because they are afraid of being suspected by their superiors. They shirk to perform their duties, and in trying to do that, they do not hesitate to put the Government to loss and also to cause injustice to the contractors.

Such a frustration of Government's and owners' engineers is a great tragedy in the present administration of India after the independence.

There are other reasons also for this frustration. 'Over-centralisation' must give place to 'de-centralisation'. There should be no interference from administrative, financial and audit authorities or from politicians. These factors result in delay of decisions, which, in turn, causes delay in payment and consequently increases construction cost. Power must be delegated to the engineer officers, and they must be left free to exercise initiative and judgment if works are to be executed speedily, efficiently and economically.

Sir, I am not giving away any of your secrets when I say that due to your broad outlook and policy of giving full freedom to the defenders of our country without any political interference of any kind, we have dealt a crushing blow to our enemies and have brought fame to our Motherland. As you had full confidence in your Generals, may I request you, Sir, to have confidence in your engineers and allow them freedom in the discharge of their duties without any interference of non-technical persons ? I have no doubt, if that is done, there will be considerable saving in our financial layouts and quicker results in all our national undertakings.

The present concept of audit is outmoded and must be done away with. The present system should be replaced by a more rational one which does not result in delays in payment, with consequent increase in costs, slow down of progress of works, and so on.

The detailed cost of departmental work is very often not correct, or not produced at all. Sometimes fantastic figures are given which are too good for belief and if the details are challenged, these are not produced, because the costing never shows all the items of expenditure which has to be incurred and which the Government has also undoubtedly incurred but not shown.

The department should consider the contractors as a part of the Government organisation; and if they give their co-operation at all stages and do not adopt belligerent attitude, good results can be achieved.

During the pre-independence days, the contracts were based on a certain concept of 'contractual relationship'. It must be known to many that this relationship had often given the contractor the facilities not to provide any supervision at all, and the work was managed by the owners' supervisors, who also prepared the bills and looked after the interests of the contractors. After independence their concept should have completely changed. But unfortunately, though it is considerably minimised, it has not fully changed. I will briefly touch here upon this aspect. We usually hear about corruption in the works of contractors. No doubt there is some truth in this observation, but does this not prevail in other business also including the Government Departments? At the same time, it must be admitted that the execution of works by contract offers less chances for corruption than when handled departmentally. In the works executed by contract, opportunities are few; but in the departmental works, it opens up all venues such as purchase of material and machinery spare parts, and all kinds of stores, fixing up of labour and transport contracts, and other items of supply for departmental works.

I lay great emphasis on the honesty and integrity of engineers. Honesty does not rest only on financial considerations but it includes dishonesty of purpose. When you know that some designs or proposal is definitely not practical, wasteful and un-engineering, and do not come forward to express it but say 'Yes Sir, this is wonderful and the best of all other proposals'—that is the 'father' of dishonesty.

Our profession is an easy and convenient target for accusations of corruption and malpractice. The main reason is that the engineers by profession have to handle large sums of money than in any other profession. It is not the monopoly or birth-right of any other individual to give a sermon on the honesty of our contractors' engineers. I am glad to say that this evil amongst engineers is not greater, perhaps much less than in the other professions and commercial establishments, where the number of such occasions may be less but amounts involved are much larger as compared with the engineers' vocation. It is amusing for me sometimes to hear from a top level man the virtues of honesty when he himself had a doubtful reputation. It sounds like

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I can speak for many hours on this and the subject of contracting but I hope the above will be enough for this occasion.

Due to the length of my Address, I have not touched upon the very important question of Housing in the Fourth Five Year Plan.

It is a fashion amongst the Presidents of the Institution, in trying to out-do his predecessors, to form all kinds of committees—both practical and non-practical—on various matters as soon as he occupies the 'throne'. I have noticed that *so many* of them were just born and died as soon as or before his term of office terminated. My submission is, Ladies and Gentlemen, that the President should take care that his enthusiasm to do something spectacular should not become an object of *ridicule* for the Institution. I do not propose to compete with them but shall try to consolidate or revive many of the useful committees and produce results without any more additions.

The President has the misfortune to receive much unsolicited and free advice as to how the Institution should be run. Many academic or theoretical ideas are given which cannot do much good nor can they be put to practice.

It was amusing to read a few years ago the statement of a non-technical Chief Minister in big headlines that *he* had *to decide* whether to save the dam or the capital city; he did not know that if there was no dam, there would have been no capital city!

It is also a fashion with the distinguished guests, both of the State and the Centre, to advise that the Institution should do this and the Institution should do that, though the realisation of many of these ideas lie entirely within the power of execution of these august individuals themselves. The Institution is after all a stone building and ruled by the Council members. It is often not realised by many of our Council members that any criticism and suggestion apply to themselves and they themselves should come forward to help and put it right.

It is usual with any Association or Institution that the President should make his 'Statement of Policy' when he assumes office. This was not done in the past in our Institution, but I shall take the lead in this matter.

I declare that:

(a) To any problem or duty that the Government or other public bodies may call upon the Institution to advise, the Institution will give its full co-operation.

(b) The Institution will not consider anything more important than making every kind of sacrifice and doing services for the defence of the country.

(c) I declare that I shall guide the Institution wisely but firmly.

(d) I shall help the Students of the Institution, who are the backbone of the Institution and our profession, in all their difficulties. Their cause shall be my cause.

(e) I shall try to visit as many Local and Sub-Centres as possible, if not all, irrespective of my time and expenditure to me, as I do not consider myself too old for this purpose. I feel that such personal contacts with the Centres *must* be kept by the President.

(f) This Institution will take concrete steps to make our Government discourage non-technical persons from being appointed or given charge of any technical undertaking, where it is the legitimate field of work of the engineers.

(g) For this, the Institution will try and help members seeking election to the *Lok Sabha* and the *Rajya Sabha* as far as possible.

(h) The Institution is not the President's personal property, and as such I shall serve the Institution not as its master as President, but as its humble servant.

(i) In matters connected with the administration of the Institution, through the Council, I shall not make compromises merely for the sake of peace but shall do whatever is fair and just.

(j) I shall repeatedly impress upon the Council members that all matters should be decided only on the principle that what is *good* for the *Institution* should be done.

(k) I shall keep on reminding the Council and all members that they should always consider the Institution bigger than any individual, however big and important.

Finally, Ladies and Gentlemen, may I ask you to rise and declare with *one voice* and assure our distinguished guest that we all engineers will carry the fight on behalf of the nation to the last drop of our blood and carry out any duties that he may call us to perform.

JAI HIND

VISION FOR THE FUTURE—THE INDUSTRIAL INDIA OF VISVESVARAYA'S DREAM *

Dr. T. Sen

Honorary Life Member

The Institution initiated and established in 1957 this Lecture in memory of Sir Mokshagundam Visvesvaraya, one of the greatest sons of this country, who apart from his outstanding accomplishments in the field of engineering, played a great role in consolidating and promoting awareness of the problems of industrialisation in the betterment of its communities. During these eight years, eminent men and specialists have, with thought and study, undertaken the task of delivering this Lecture. This task has fallen on me now and it is indeed an onerous one. But I have accepted this assignment with all happiness, for it has given me a chance to associate myself with the memory of this great man, a freedom-fighter in more than the accepted meaning of the term, whose wisdom and strength, conviction and courage, vision and understanding, have ensured for him an immortal place in the foundations of the integrated structure we have aimed at through our successive Five Year Plans.

The edifice of national life seeks in constant demand architects to elaborate its innumerable, and rather elusive, elements and to bring them together into an organic balance. Ours is a comprehensive society with many castes and creeds, ideals and aptitudes. Its professions and ways of life are as diverse. The evolution of a morally free, physically fit, harmoniously developed autonomous whole out of this diversity has been a challenge from the time man began to shape nature to his own needs. Kings and common men, the wise and the valiant, alike have set themselves against this immense challenge, sharing their beliefs and experiences in the moulding of this myriad-faced society into the one 'individual' of their dream. And it is in this awesome background, in a time of great moral and material want, hidebound under an alien rule, that Visvesvaraya commenced his great task of reconstruction. building a new and better India, which could show itself up in the community of nations. Untouched by politics, he gained, through selfless work, the warm affection of his countrymen and others. It is just this unanimity which gives us a glimpse of his stature and personality. Brilliance and intellect brought to his work a high moral content in which favour and special pleadings found no nourishment. He sprung, as he did, from a traditional Hindu family, as if predestined for a unique mission, which took him into careers wide and varied—engineer, author, economist, industrialist and statesman. He fought passionately and tenaciously whatever the cause was, fostering truth into the still young institutions of his day—an inestimable service which he carried out with dignity, brilliance and generosity, melting the distrust between individuals and winning many friends not only for himself but for the country. He was no doubt an engineer by profession but he was something much more. A new and profoundly felt feeling of community bothered him. In the consciousness that full life was a dream in the conditions that prevailed and hunger and deprivation took away the better part of men, he was convinced that his own mental attitude and the springs of action underlying his approach to tackle these problems in the country needed metamorphosis. Survival and success depend on exceptional moral and physical effort. They do not come about without effort.

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* The Ninth Sir Mokshagundam Visvesvaraya Lecture.

War on hunger and poverty need as much engineering as war for expansion. Fresh desires and new ambitions require for their fulfilment persistent and devoted regimentation to these precepts : hard work, planned discipline, aimed efficiency, courtesy and service. These are also the qualities essential for harmony and unity and cannot be acquired without preparation or training. In this sense, every effort, irrespective of its description, needs the 'engineer' in every man, to bring out his working power, sense of duty, and prospects of self-sufficiency and success. A common slogan of the West to which Visvesvaraya attached the greatest importance was 'If you do not work, neither shall you eat'. Here lay his philosophy.

There are many ways open to the engineer to help himself and the others around him : To quote Visvesvaraya, 'In the present crowded state of the world, sound habits and good behaviour are indispensable for every community to constitute itself a body of successful business men. The average citizen will learn from experience that what keeps him in sound health and prolongs his life is organised planned work and disciplined habits.

Regular hours of work, punctual attendance to duty, standard business habits, appreciation of the value of time are some of the practices which help to improve the individual's chances of attaining a prosperous, carefree, healthy life.

Natural intelligence and capacity may be high or low but they have to be further developed by forethought, industry and willpower to obtain their due reward.

Success in any profession or trade is due largely to the capacity, individuality, integrity and foresight of the person who attains it. Man's success in life depends on man's own exertions. Most shipwrecks in life, perhaps all which are not caused by accident, occur because people follow pleasure and avoid pain. A man whose maxim is to seek pleasure and avoid pain is sure to go to the wall. Mastery over pleasure and pain is the basis of any permanent and well deserved success in life. It is the stamp of dignity that moral actions bear : it is the indispensable condition of a great man's greatness.'

The label 'engineer', in the above contexts, is, so to speak, the birth certificate of a man of work—his identity card. The distinguishing qualities expected of each such engineer have been laid down on the basis of academic attainment or practice and convention and as such, have become to be regarded as authentic. The active spheres of each, though prescribed, have been shrivelling into 'indistinguishables' in the ocean of the present-day scientific and technological race.

Today, technology nourishes us. The immensity or the want of products and luxuries produced by rational scientific and technical results keep us either in peace, or baked and boiled in turmoil. We want, as developing countries, to become industrialised, mechanise our farms, and escape starvation on the one hand, and to fight an aggressive enemy on the other. We look to men, engineers, to arm us with the necessary material abundance or the operative means of force accordingly. While we accept peace and disarmament as most vital for co-existence, we cannot desist from our minds the need for disastrous weapons and techniques, the breeding ground of all catastrophe. In the approach to either of the summits, we need technical ability, and a slip here may well mean a fatal end.

Man today is well aware of his needs ; he knows that to survive with dignity he must build up a conscious understanding of the good and bad of technology.

The developments in the technological world of tomorrow are made by the engineer of today. In his public assignments, the engineer's responsibility is enormous, his field of activity broad. He must be more than a pure technician to be truly successful. He must deal with people and direct them, to make his contribution to the building of the human spirit. He must shoulder the burdens of an outlook that generate strength and grandeur not only in the discovery of facts but in their application ; not in receiving but in giving ; he has to continually regenerate contemporary knowledge and technical skills to bale out drudgery and insufficiency ; and he must optimise for a social end an economic and workable answer.

War or peace, no matter, men have to live, and to live, they require contrivances which can give them food, shelter, clothing and protection. Military forces or civilian agencies cannot operate in a vacuum. They have to be backed up by an integrated national effort. What is of ultimate importance is the quality of engineer-support the nation can provide. Just as it has to face emergent demands for its preparedness in the case of war, the society has to protect its codes, patents, safety, health and economic and social machinery in times of peace. The growing inability of the lay public to assimilate the advances and the validity of technical achievements that are being thrown out in an unending measure has placed a weighty burden upon scientists and engineers. In this background, it has become obvious that it is the engineer's responsibility to contribute his professional competence towards the solution of society's problems. The engineer, in this task, cannot just have the role of a mere consultant. Exercise of integrity in this role is not merely a question of technical insight or accuracy. The engineer needs to develop an awareness of the social forces, the humanities and their relationship to his own field of work. He must have active participation in the affairs of the neighbourhood or the nation ; his responsibility in the protection of the nation's heritage of integrity and morality is more than casual. Over and above the requirements of the country's laws are his obligations as the good neighbour, the helpful colleague and the practicing professional. In summing up, I am tempted to quote from our Code of Ethics :

'Many facets of life elude definition and ethics is one such, for ethical enquiry is by no means the product of a passive observance but something which we cannot claim to know until we have made it a part of our own experience. And yet we seem to be familiar with its concepts when we characterise questions of right or wrong, of personal responsibility and social action, of human and moral values, of honesty and justice, of courtesy and fidelity, of knowledge and enterprise, of honour and dignity, of competition and obligation—all ingredients of an intellectual concept we talk of as 'integrity', the keystone of professional conduct. Do we then discern that ethics means tenets of professional morality, or is it a superabundance of legalistic documents that try to compel observance of such tenets ? In neither indeed seems to be the answer. Its vision is simple and its purpose sanctified —to remove the blinkers of unhealthy functionalisms, self-interests and delayed and differentiated reciprocities and hold fast the fundamental values of altruism, generous thinking, tolerance and understanding in the pursuit of professional disciplines in whose fertile soils the seeds of many an effort can flourish to do the highest good to the largest number.

'The task of ethics', said Jacques Maritain, 'is a humble one but it is also magnanimous in carrying the mutable application of immutable moral principles even in the midst of agonies of an unhappy world as far as there is in it a gleam of humanity.'

This is the picture of the engineer that I have in mind. In short, the engineer is both the product and producer of our exciting times.

He must therefore be equally in readiness to cope with the escalating tasks stemming from sudden aggression, and expose and acclimatise himself to the uncommon—elevated altitudes, intense colds, burning deserts, bleak and desolate forests and rugged mountain terrains to keep the wheels and weapons of the army going. It is a truism that in peace a nation has to prepare itself for war. Restive neighbours on our borders and an ominous unabated build-up of hostile forces on the rampage have forced the nation to make the abstract a truism, an immediate and vital part of her national plan.

He is therefore called upon to match up his efficiency and operational fitness to the modern mechanised army not only as an engineer but as a gallant soldier as well. Maintenance and repair of equipment unheard of a few years ago, and balancing the intellect to understand equipment that are progressively getting sophisticated in design, construction and functional ability have needed more than his own brains. With the equipment we have today or are likely to have in the future, tanks like the Centurion, the 20-pounder (British) guns, the L-70 (Swedish) with associated radar equipment, the new types of miniaturised and transistorised wireless sets and counter-weapon surveillance radars, technology in the army has advanced rapidly. This trend is bound to continue unabated in the future as well with the introduction of guided missiles and such other newer weapon systems. As an age of electronics, engineering skills and techniques have tended to become highly specialised in nature requiring specialisation not only in engineering and technical skills but in management methods, to be able to meet the challenge of the rapidly changing technology in warfare.

The gallant infantryman, the dashing tankman, the game gunner, the ubiquitous sapper and the steadfast signalman can fight or function when armed with engineering skills. The craftsman engaged in making and mending the weapons, the tanks, the guns, all required to serve the nation, cannot go without engineering.

The development of integrated defence systems has come about over the last decade and few have realised their importance or even their existence. Their appearance has brought new importance to many sciences and even fathered some new ones. Air defence in the present world is no longer an art where a country's defence to attack is decided by conferences and discussions between high ranking officials. The fact is, men just cannot think of all the possibilities and plan accordingly. Nowadays computers and electronic brains have come of age in all large and some not so large countries of the West. The defence programmes are fed into these and the results are optimised so that the most power is obtained for the least cost to the country compatible with the complete destruction of the enemy before the country can no longer carry on effectively. The results are then obtained in the form of where to put bases, what type of equipment to buy, and the specification thereof, when to buy, whether to use missiles or aircraft or a combination of these. PERT, a method of scheduling operations for a project, was specially developed for the Polaris submarine and allowed it to go into service two years ahead of what would have been possible with normal methods.

To do these, the defence planner has to turn to his intelligence sources, from whose data a list of the enemies, forms of air attack, and the numbers of each of the weapons he possesses are made. Here the need for accurate intelligence becomes vital and can save a country millions a year. Therefore, for the successful appreciation and execution of engineer tasks—these broadly fall into three categories: in the battle area; in the communication zone leading up to the battle area; and in the base which supports and sustains the latter—engineer-officers must understand and know tactical concepts of battle fully, in addition to being sound professional engineers. With the cost of weapons spiralling, non-integrated, haphazard and prejudiced decisions of men other than the engineers cannot just be afforded.

I have drawn attention to this manifold nature of engineering as I have described so far and which I have continued to elaborate further, not only as a fascinating field of study but to render some background concerning the need for the formation of special professional groups in these fields in our own country, specially when we have given the utmost priority to defence.

There goes hardly a day without a report giving attention to current achievements in medicine. Such achievement has been the result of coordination and application of engineering thinking and technology. Some of the advances that immediately come to mind, to mention but a few, are: (i) the development of artificial pacemakers for the heart and other organs; endoradiosondes, *i.e.*, small radio capsules employed for telemetering information from various portions of the anatomy of a human under near natural and hence physiological conditions (a recent and particularly spectacular news report contains an account of an effort to learn about the nature of forces in the mouth when chewing, drinking and swallowing. A group of American workers are said to have equipped false teeth with minute radio transmitters which deliver a signal each time two spots of gold on the chewing surfaces of two opposing teeth come together. These signals are then correlated with the indications upon an electromyograph (muscle activity meter) attached to the skin of the jaw); (ii) the artificial limbs and their control systems developed in Russia; (iii) the measurement of the electrical activity of the heart and the brain through the media of the electrocardiograph and the electroencephalograph respectively and notably the impact of the latter on brain surgery specially with regard to the location of the foci of lesions and tumours; (iv) electronic analogues of physiological function; and (v) digital computers as an aid to processing and interpreting data of a scientific and clinical character. The accomplishments mentioned here have created the need for trained persons of a special type and a new breed of engineers has been emerging in the fertile areas oversea where virtually all of the vital advances are being made. The appellations by which such engineers are known are varied, the most common being 'biological engineer', 'bio-engineer' and 'bio-medical engineer'. It is becoming evident that a demand exists in our country as well for engineers of these types and there is a case for the study of biophysics and bio-medical engineering in our institutions.

Engineers and doctors are taking advantage of the latest technical developments in control engineering and applying new techniques to the design of artificial arms. The most advanced artificial arm in the world will soon be undergoing its final testing trials. This artificial arm, or prosthesis in medical terminology, will be an electronically controlled electrically driven device, motivated by signals from the surface of the skin. Several similar projects are being carried out in other countries. A miniature transmitter is being developed which will telemeter the muscle output through the skin without the need for surface electrodes. In yet another system, myoelectric signals from the wrist flexors or extensors are used to switch on the control. Work on the development of a new electro-pneumatic valve, and a simplified mechanical layout for the pneumatic system are said to be in progress.

Attention has not been limited to these. Designs are in the offing for artificial hands which will have several movements, and look similar to the human hand. A hand which will open and close four fingers together and move the thumb independently has already been developed.

The artificial arms do not represent the limit of necessary cooperation between doctors and engineers. In fact, the servo-arm has attracted many workers, often working away from patients and from other required professional disciplines. In the last fifteen years, we have seen abroad the medical profession accept engineers as equal partners over a wide range of activities. Several schools of medical engineering have grown up as a result. There is one at the University of Strathclyde, financed with a large grant from official sources. This is looking at the mechanical behaviour of skin and tissue and at the mechanics of walking as examples. The University College of London is investing a major effort in the control of artificial limbs. Loughborough has a large grant to investigate the anthropometrics and needs of wheel-chair patients.

The papers read at the gatherings of some of the biological engineering societies in the West have displayed a wide range of activity, which include artificial kidneys, heart-lung machines, radio pills transmitting data from within the body, prosthetics, measuring techniques, breathing machines, indicating the limitless extent to which engineering can coordinate with medical science in the welfare of mankind.

Industry has not failed to take note of the tremendous potentialities of medical engineering—a better name than human engineering, an Americanism for 'ergonomics'.

The development of infrared for both military and commercial applications received impetus during the Second World War. The history of infrared dates back to 1800 when Sir William Herschel, the famous astronomer, coined the phrase 'invisible light'. The term infrared is used to refer to the portion of the electromagnetic spectrum between the visible region and the microwave region. All objects at a temperature above absolute zero emit infrared radiation. This radiation increases as the fourth power of the absolute temperature. The temperature of such items as rocket motors, jet engines and furnaces makes them suitable for infrared radiation.

At the present time, the use of IR for detection is drawing the most attention and poses many challenges for the young mechanical engineer. IR field occupies the same position that radar did at the beginning of the Second World War.

The practical use of infrared is still in the pioneer stage, and in the opinion of many, it has a 'bright red future'. The potential of infrared utilisation is unlimited, and many new applications will be evolved during the coming era of technological progress. Infrared principles are used in spectrometry (identification of chemical compounds); detection (missiles and objects in space); photography (infrared film); space navigation; weather forecasting; stabilization of space vehicles; astronomy; process-control applications; pyrometry; and fire-control systems.

The infrared field is a combination of physics and engineering. It has required the services of many types of engineers and scientists and offers challenges in many fields.

When we look at the buildings around us, or at the bridges and towers which abound in every big city or hear the drone of a jet plane, we are viewing the accomplishments of a score of different types of engineers, perhaps the devoted efforts of several thousands of them. The street we walk upon was laid out by the civil engineer, its construction planned by another engineer. Bridges and water towers are similarly the construction of one group of engineers, erected by another group. The airliner is designed, tested, and its development supervised by hundreds of engineer specialists qualified in that particular field.

The unbreakable plastic plate or ceramic on your table is the brain child of chemical and ceramic engineers. From the toothbrush to the spaceship, from the typewriter to the automobile, the hands and brains that perfect each new technological achievement are the hands and brains of the engineer. What then, is meant by the word, engineer ?

The engineer as we know of old was a rugged outdoorsman who erected bridges possibly without plans or without being bothered with the period he occupied to do it. Today in real life, the engineer is the partner of the scientist in the tremendous technological race of our times. The work of both is closely knit and interrelated, and civilisation cannot progress with just one and not the other.

A U.S. Presidential Commission on Scientists and Engineers defined a 'scientist' as one who seeks to extend the boundaries of knowledge. The 'engineer', on the other hand, has the task of combining the knowledge of science with his knowledge and awareness of the needs and limitations of human society to develop and create new things for human use.'

'The scientists and engineers form the team that paces today's technology. In science lies the foundation upon which the engineer builds towards a goal of the utility, comfort and advancement of man. The engineer is concerned with machines, the environment in which they operate and the men who work with them and to effect their control.'

'The profession of engineering,' concludes the Commission, 'has thus become one of the most important in modern society. Our civilisation would deteriorate, would become too weak to survive without the work of the hundreds of thousands of trained men (and the too few women) who create new and useful products, who envisage, design and build great factories, intricate communications, power and transportation systems and vast irrigation, navigation and flood control products.......'

While basically the scientist is a thinker and discoverer, the engineer is the man who has to harness the discoveries and formulas enunciated for practical utilisation. In fact, the tremendous upsurge of technology has brought about the need for a new group of 'technical managers' to bridge the gap between the scientists' laboratories and the more practical world of engineering. An example of this is nuclear energy, which was brought from the laboratory just during the Second World War and in a matter of less than two decades was ready for use to propel ships and light cities. When we contrast this with the steam engine, the principles of which were known to Greek scientists centuries before the birth of Christ, we know that it did not find practical and large-scale use until over 1,800 years later. The present advances have been shortening the technological lead time, rendering keeping abreast of the latest discoveries and their possible uses almost impractical. For this reason, the scientist-engineer has forced himself as a key member of major industries and government development agencies in advanced countries.

Going back to engineering alone, we find many specialised areas ; yet there is still a wide range of different types of jobs an engineer may perform—one may be a research engineer, another a design engineer, yet another a production engineer, and the fourth a maintenance engineer.

All these above functions are different though interrelated, yet all these engineers described may be mechanical engineers.

It may not be out of place to mention here that the technological world is opening its vistas to newer and newer engineering branches. Apart from the accepted major category of engineers, *viz.*, civil, mechanical and electrical, and the other major groups, *i.e.*, materials engineers, automotive engineers, petroleum engineers, and sanitary engineers, included in all the above broad categories are many gradations—for instance, materials engineers may include engineering fields some of which, such as nuclear engineering, are bound to metallurgical, plastics, and ceramic engineers. There are also many other become major segments of the profession transforming it in years to come. Just a few of the other specialities are marine, architectural, acoustical, cryogenics, welding, industrial and heating and air-conditioning.

All industries, large and small, need engineers, but the major future opportunities for large-scale engineering employment lie with the so-called 'growth' industries. What I imply here is, these are industries dynamic in nature which, over a decade or two, will tend to double or triple. In almost every case, the growth industry has to have its growth and stepping up in the shelter of advanced science and engineering.

In today's hectic race, brand new fields have been coming into existence, beckoning giant industries in a matter of ten to twenty years. One instance is electronics. The fabled transistor; the miniature communication systems that send signals back to earth from 22,000,000 miles in space; the computer; the television—all are products of electronics, an industry that was almost non-existent in 1945. Other such fields already are on the horizon. One well publicised is the nuclear field, but an example of an even more infant industry is 'radiation chemistry', a field that has born of a merger of nuclear and chemical science. One of the major future uses of this branch, for instance, will be to irradiate food to make it possible to keep it almost indefinitely in or out of a refrigerator without spoilage. Although most of its promise lies in the future, radiation chemistry is of use even today. An instance is the irradiation of plastics.

Each industry employs a wide range of different types of engineers over and above the engineers with specific training in the field. For example, the aerospace industry needs a large number of aeronautical engineers, but, in addition, it also requires mechanical engineers to design machine tools linkages, controls of a missile fin surface, or a landing gear; civil engineers can apply structural principles to design not only missiles and spacecraft launch emplacements, but the structure of the vehicle itself. And just about every type of engineer from the materials specialist to the electron-electrical designer has a vital role in this combination.

Similarly, the oil industry naturally looks up for engineers from geological and petroleum or mining engineering specialists. However, it too requires civil engineers to supervise design and construction of pumping systems, storage facilities, cracking plants and the other auxiliaries. In the chemical field, chemical engineers are likewise supported by such specialists as electronic engineers. In this case, the electronic engineer may be required to monitor a process control system or to automatically run many chemical operations, right up to the complete control of a major chemical process plant.

This brief discussion will indicate how varied and flexible engineering can be. I have also made just a mention of the tremendous future possibilities of engineering particularly in the continuing influx of brand new industries to serve war and peace alike. One may ask, wherefrom can engineers for such industries come? The answer is that new types of engineers cannot be trained in a short time in colleges, since in most cases, the colleges will not have been themselves aware of what will be required for a new and previously unknown technology, and also because of the lack of modern equipment which generally needs to be imported from abroad.

Let us consider electronics, for example. Electronics is related to the theory involved in electrical equipment. But the products turned out by the electronics industry differ radically from the heavy electric generating equipment, conventional motors, radio tubes, etc. turned out by the electrical industry. Electronics produces the highly versatile computers, solid-state semiconductors, and other sophisticated equipment as are used today. Thus the electronic engineers must cope with a whole range of new problems other than those faced by engineers in conventional electrical firms.

But as electronics shaped up as a separate industry, it had perhaps to draw upon the young-in-heart, adventuresome engineers from other fields—electrical, mechanical, etc.—who desired a change and a chance to work in a new, challenging industry. Where, then, will engineers for radiation chemistry come from? Again not from specific 'radiation chemistry engineers', but from chemical engineering, nuclear engineering, and other related fields. It is this potential trade-off that again renders engineering a versatile field, one in which the engineer with capacity, intuition, ability and drive has the chance to 'get out of a rut' into something paying and exciting.

An early form of army engineer was Ramses II's Superintendent of Works in the fourteenth century before Christ; army engineers had built the pyramids 1,500 years before that. It was not until 1818 that engineers in England broke away from the military sphere and established the Institution of Civil Engineers. They styled themselves civil engineers because they wanted to proclaim their new status—they were no longer connected with the military.

In America, the Corps of Army Engineers was established by the Congress in 1802 when West Point was begun. The engineers ran West Point until 1866. With the founding of the American Society of Civil Engineers in 1852, engineers and greater specialists became available; mechanical engineering took on a separate identity, and was followed by mining, chemical, electrical, aerospace, materials, and others.

During the Second World War and after, aeronautical engineering had all the glamour. The war fliers made anything connected with aviation attractive. Aeronautical engineering treads on a number of specialities and the wide field has never been saturated. It still isn't.

Nonetheless, we require highways, hydro projects and airfields, which again call for construction of bridges, sewers, water channels, telephone lines and structural work. These all but spell out the civil engineer, the structural engineer, and so on. We know that civil engineering is required in our everyday life. Every piece of land has had a civil engineer either walk over it, or plot out parcels of land for the use of people.

Every construction first sees the light of the day on some civil engineer's drawing board. It is he who has to sketch the streets, show where utilities should run, and the course and depth of underground works and sewers. He has to arrange for drainage so that the streets do not flood into rivers in a storm. He has to plan to drain or fill low places to avoid water stagnation.

The civil engineer who has a natural love of water employs himself to measure water flow in rivers and arranges, by means of dams or other flood control devices, to regulate them. He plans harbours, breakwaters, sea walls, and jetties. Wherever there is a harbour, he must have to plan wharfs, docks, warehouses, service streets, roads and other utility services. Rail service may be required and certainly power of some sort, again the engineer's enterprise.

The construction engineer is the specialist who has to prepare for building large brick, steel, or concrete buildings. This means changing the land surface by blasting, using mechanical equipment such as the steam shovel, bulldozer, rock drill, and pile driver. Construction engineers have the world as a workshop. They have to team up with hydraulic engineers to build our giant dams. Again, wherever oil is sought, we see there the civil engineer spotting wells.

The hydraulic engineer who teamed up with the civil engineer for the great irrigation projects has his field of 'fluids'. Pipelines that carry water, oil, gas and other petroleum products are his responsibility, as are the pumping stations that keep the fluids on-moving. He is needed in industry as well where he has to design hydraulic systems that automate the military planes, or the transport jets, or the buses that carry millions of workers every day. The civil engineer is all important to railroad operations. The man on the job who knows his work inside out is the one it needs. It is the civil engineer again that routes the road bed, the yards where freight is switched about, the shops where the engines are repaired; as well as the railroad buildings, the stations, the bridges, the underpasses, and the tunnels. The transportation engineer does much the same kind of work for our great air terminals. Here he is concerned with runways, run-up ramps, lighting passenger stations and lounges, and the like.

No city department of water can operate without the sanitary engineer. He may be a public health officer charged with the purity of drinking water. In this capacity, he has to plan and maintain systems of lakes, dams, reservoirs, wells, treatment plants, and pipelines and get rid of the waste and sewage water after use by industry and by people.

Last but not the least, is the teaching engineer. He has a cloistered life which is remote from the strains of active business competitions.

This list is not, however, the sum total of the miraculous touches of engineering. In the background of our exploding population, new towns, new cities and all the necessities that permit a community to 'live and grow' must have to be shaped. The whole world is growing, with the underprivileged countries offering a continuing challenge. Many engineers of many types are the need of the times. The space age is with us too, and, to many young men, anything less than space engineering seems to be too prosaic.

Be it for defence, industry, commerce or the community, public works have no single purpose. They represent a great variety of purposes for serving the public need. Most natural resources are in limited supply and must be used with full recognition of eventual exhaustion. This, of course, is stating the problem in its extremity. Exhaustion of supply in some situations could be anticipated only in the distant future. Even so, the lack of immediate danger could hardly be a justification for waste. Rich arable land is a precious natural resource and unless continuous effort is made to restore its fertility, it can become useless. Depletion through excessive farming over long periods is a common wasteful practice in agricultural countries. Better methods of farming can reverse this trend, but some other natural resources cannot be as easily replaced—oil and mineral deposits, for example. These are in limited supply and, subjected as they are to immediate and often strategic pressures, they require special governmental regulation and control. We tend to forget the natural gifts of land and water which contribute so much to superior productivity. A country which is without sufficient land suitable for cultivation can in many instances increase the supply by investing capital in public works which promote agriculture. Industrial development requires food supplies at low prices. If food can be increased by conservation and development of water and land resources, this is a first step to general national improvement for industrialisation. Of course, there is no point in forcing production of inferior farm products by means of expensive investments in reclaiming land which would be better left for other purposes, for instance, woodland or forests for serving either immediate or future recreational needs. It would be better to import food on a very limited scale and that for a very short period of time, than to launch an uneconomic public works programme.

Unfortunately, the government official is likely to have a limited perspective, accustomed as he is to viewing each kind of public works project by itself—a highway, a bridge, a dam, a public building. Budgets are made up largely by adding together projects, each of which is viewed in this way. But if a programme is examined with the intention of coordinating these parts and if, in addition, it is considered in its long-term context, the results are different. The outcome in public works planning when carried to its logical conclusion is nothing less than designing a setting for the economic life of the whole country. Public works planning cannot be based solely upon the physical features of a country as they exist at a given moment, it is quite the contrary; public works planning is the work of the engineer, an attempt to forecast location of these items and to some extent direct them to the most effective system which can be foreseen and devised.

When planners have gone this far, there is no logical way to refuse to take a further step: specifically, to take account of the effect on the economy of the process of constructing public works. Economic life is affected not merely by the services rendered by the completed works but also by the very process of completing them. It is a question not only of the kind of physical equipment with which the community will ultimately be supplied, but of the stability and prosperity of the people as they are influenced by the process of building equipment. In brief, the logical development of public works planning, beginning with the narrowest conception of it, leads inevitably to a kind of planning which includes the actual effect of construction of public works on business prosperity. This accomplishment is clearly the work of the trained specialists equipped to observe, record and compile information in meaningful terms which once gathered can be assembled and presented to making public or governmental decisions. These factors primarily hinge on one factor—affording the widest mobility in the broadest sense of the term to such men. The engineer's tasks cannot however be executed in isolation. They have to fit into the strategic or tactical framework of the national plan. Naturally the overriding factor which determines the type of engineer required is the training and employment he should be given.

The engineer is all this and more. His influence alone can build up a liveable society. Stability depends on three things: an organized society, a flourishing industry, and adequate communication, and these are the only factors that can bring in reorientation preparatory to a better and more understanding civilisation.

Visvesvaraya was intent likewise on such reorientation, and drew for this purpose, inspiration from men who had been the salt of the earth and who had leavened the society around them with their superb gifts. He himself was superb, with his evangel of ceaseless and selfless work.

In addition his unremitting labour to the welfare of the States he served, in addition to organisation of industries and of centres of technical education and of communication links, his attention to village reconstruction was unflagging; and his ideas which were discountenanced as impractical and newfangled, are now surprisingly the commonplaces of planning programmes. He emphasised the importance of rural education and of planned productivity, and also that every agricultural family should be given a subsidiary industry or occupation. At a time when deficit financing was severely criticised, he pronounced that the greater the spending capacity of a country, the more progressive will be its character. His book 'Reconstructing India' is a thorough and comprehensive statement of India's requirements. He was nearly the first to insist upon a wise assimilation of modern methods of production, marketing and distribution and he was never wearied of referring to countries like Canada and Japan as examples, to be wisely, but not slavishly, copied. He dealt with social reform, the building of the political system from the village upwards, with insurance and technical education, with uplift of women and the depressed classes, and above all the problem of unemployment, and reorganisation in villages and the countryside as the sole means of economic stimulation and uplift. To him we owe the inculcation of the importance of vital industries like shipbuilding, machine tools, chemicals, paper and motor vehicles. He put forward schemes of nation-building modelled on methods adopted in America in order to cultivate the spirit of initiative and the acquisition of business disciplines as well as the eradication of obsolete practices; the importance of science and uptodate scientific methods to industry and agriculture for increasing food supply and raising the standard of living.

Tardily and almost reluctantly his outlook and his services were appreciated and he become successively the President of the Indian Science Congress, the Indian Economic Enquiry Committee, the New Capital Enquiry Commission, and the Irrigation Enquiry Committee. The reports produced by these Committees form the basis of present-day economic thinking in India. Through his 'Planned Economy for India' and 'My Working Life' and as President of the All-India Manufacturers Association, he pleaded for an all-round development of agriculture and industrial planning. He was fully conscious that without improved social conditions it would be difficult to bring about economic regeneration. He said 'The unfettered spirit of industrialism will result in anarchy and violence unless the employing class meets the problem by peaceful methods of negotiation and conciliation.' Looking back on the evolution of the techniques of raising financial resources for our Plans, one will be amazed at his confidence and faith in the progress of the country, a faith which events have to a great extent justified. His actions, speeches and writing are replete with ideas and programmes which—they were received with scepticism 30 to 40 years ago—have passed into the current economic change of the country and its national policies. His social philosophy was enunciated in words like these: 'The nationality of our people rests on a religious and fatalistic, not on economic basis, as in the West. The Hindu ideal of life is that it is preparation for the next and not a place to stay in and make ourselves comfortable. There is yearning for the old ideals and a half-hearted acquiescence in the new, and on the whole the genius of the people is even today for standing still. If we are to follow in the wake of the other countries in the pursuit of material prosperity, we must give up aimless activities and bring our ideals into line with the standards of the West, namely to spread education in all grades, multiply occupations and increase production and wealth. All other activities should conform themselves to the economic ideal.'

This sounds very much like the present economic creed of our country. While the government is resorting to regimentation to achieve economic ends, Visvesvaraya remained a believer in private initiative and enterprise with the encouragement of the State and other expert aid agencies. He did not indulge in the past or in political argument. He talked of the present. The ideas he expressed in 'Planned Economy for India' in 1934 have an astonishingly modern touch about them. In those days, the expression 'underdeveloped nations' was not current. Neither among the world statesmen nor among economists was there any awareness that poverty and hunger were world problems. While Gandhiji felt this and was working primarily on the political and social planes, Visvesvaraya worked at the very roots of the problem from the technical and economic planes.

Talking of agriculture, for instance, he wrote : 'The Indian cultivator is the mainstay of the economic structure of the country at the present time and he gets very little sympathy or aid to improve his condition......His chief needs are education, instruction in modern methods of farming, and efficient organisation for rural uplift. Lack of organisation has been the bane of agriculture as of so many other activities of national importance in India......'

'The outstanding defects of rural life may now be summed up. They are : the excessive pressure of the population on land, the small size of holdings and their progressive fragmentation, the primitive methods of cultivation followed, the waste of farm measure, irregular hours of labour, insufficient and uneconomical utilization of women's services, the lack of finance for farm work, the old-fashioned character of the subsidiary occupations pursued, the crushing indebtedness of the ryot, short employment, universal illiteracy and phenomenal poverty.'

Very much the same was said when the First Plan was published and was repeated when the Second Plan was formulated. Subject to changes, the Third Plan had this very theme stressed and the Fourth Plan has followed. The remedies that we are thinking of today, namely, community development, extension of cooperatives and the like would follow directly from the thesis which he propounded many years ago. He attached utmost importance to industries, particularly heavy industries, almost exactly in line with the current policy. He foresaw the need of the management agency for the scrutiny of various abuses that have crept into the working systems. Time and again he referred to the massive assistance required in the initial stages of industrial development of the nation. Visvesvaraya the engineer is dead and his precepts are now old. The formulations he propounded many years ago have still remained, some having become a part of the accepted policies and some others will become such.

In ending this Lecture in memory of the great Visvesvaraya, I cannot resist from referring to you yet another personality of our times, Churchill, for to both of them 'life was work', and work personified the engineer in men. One senses in both the hand of the trained scientist and engineer.

'During a visit to the United States some years ago, Churchill toured an oilfield. On being shown an oil derrick, he asked the President of the company a question about the detail of its working, but the President was unable to help. Churchill insisted on an engineer being found to explain the technicality. This took some little time, and in fact delayed lunch an hour, while Churchill went to the top of the derrick with the engineer and listened to the explanation. When he came down, he turned to the President and said, 'Now I will explain to you how your derrick works !'

The incident was characteristic of that great man. In the First World War as First Lord of the Admiralty and Minister of Munitions, and in the Second World War as First Lord again and then as Prime Minister and Minister of Defence, he had the power to foster some of the wildest proposals for new weapons and defence equipment. He seems never to have shrunk from these decisions. He was not technically qualified, but this did not deter him. He was surrounded by technical experts, but they could not frighten him. He grasped every opportunity of innovation in design, giving an immediate order for this or that to be made in quantity even before the experts were satisfied. He undoubtedly gave his supreme authority to a number of projects which were worse than useless, but the overall effect of his enthusiasm was to ensure that good use was made of the nation's creative talents. Engineers are often better for working under a lay leader who demands the seemingly impossible, for only thus do they become aware of their full creative powers. The conflict between Tizard and Lindemann, however, highlighted the difficulties created for his technical advisers by his fertile imagination. He was not markedly interested in science as such (Haldane and Balfour had greater influence in this respect) but he took great delight in everything from small arms to battleships. In the wilderness years between the two World Wars, when he learnt to lay bricks and built a dam and a swimming pool at Cherwell, he was close to those scientists and engineers who, like him, were pressing for action in the development of armaments.'

Summaries of Papers Published in the Journal, vol. 46, no. 4, pt. HI 1, December 1965

HINDI SECTION

Use of Radio-Isotopes to Determine the Density of Soil and Freshly Placed Concrete

Dr. Janardan Jha
Associate Member

The rapid development of atomic energy has given wide varieties of isotopes to the world. These radio-isotopes are being used successfully in the oil and paper industries, metallurgy, etc. The isotopes can be successfully used for the determination of the density of the soil at the site. Advantage of the use of radio-isotope is that it is possible to determine the density of soil without disturbing its natural condition. The principle is based on the absorption of ν-rays passing through a layer of soil. The absorption of ν-rays will depend upon the density of soil. The underlying theory as well as an example are given so that the necessary calculations can be done without difficulty after the experiment has been performed in the field. Based on the same theory the density of freshly placed cement concrete can also be found at the construction site. The arrangement of the apparatus will be different. The set up has been described in the paper. Testing freshly placed concrete by this method gives the possibility of controlling the quality of work specially in mass concrete work before it is too late. Immediately the amount of compaction of concrete can be known. If the compaction is less, then the compaction can be increased by giving more vibrations.

Bridges Through Ages

P. K. Mukherjee
Non-member

The earlier times, bridges consisted of logs of wood placed across streams, or ropes hung across rivers. Arches of stone and bricks were later on used for construction of bridges by Summerians, Egyptians and Romans. In India, wooden cantilever bridges were built in ancient times by extending logs of wood from abutments. Such bridges are still built in hilly regions in Northern India. The oldest existing bridge in India is at Jaunpur across the River Gomti built by Sher Shah in 1540-54 consisting of arches of bricks. Theory of structures was developed in Europe in the sixteenth and seventeenth centuries, and steel truss bridges began to be constructed. Different types of trusses were developed for construction of large span steel [illegible] girders over rivers for heavy railway engines. Steel of high tensile strength was also develop[illegible]ed and suspension bridges of large spans created. Techniques of constructing piers in river [illegible] beds with deep foundation were also gradually developed. In the nineteenth century, the [illegible] science of reinforced and prestressed cement concrete also greatly developed, and cement [illegible] concrete bridges of aesthetic designs are now being built throughout the world.

Construction of Tunnels

Tej Narain

Non-member

This paper describes briefly the history of construction of tunnels from the earliest times. The earliest known tunnel was built in Rome in 52 A.D. which was 3½ miles long and 400 ft. below sea bed. The science of construction of tunnels developed after the invention of steam engine early in the nineteenth century. The first long tunnel was constructed in the Alps in 1857 to 1871. Since then many tunnels have been constructed, one of the longest being Simplon between Italy and Switzerland which is 12 miles long and was constructed in 1905.

Photogrammetry

Tej Narain

Non-member

This paper describes briefly the science of taking aerial photographs and their interpretation with the aid of stereoscopes. Plotting the photos on papers is done in such a manner that even contours of land can be correctly delineated. This is a very useful aid for the surveyor.

Summaries of Papers Published in the Journal, vol. 46, no. 5, pts. CI 3, ME3, and ET 2, January 1966

CIVIL ENGINEERING DIVISION

Rapid Analysis of Thermal Stress in Intake Tower of a Hydro-Electric Project

B. Pant

Associate Member

and

P. T. Badhe

Non-member

The R.C.C. intake towers in a hydro-electric project support the trash racks and operate the gates at the intake end of the headrace tunnel or conduit. These structures remain partly under water and partly exposed to atmosphere; and hence, considerable thermal stress develops in them at certain periods of the year, particularly in the tropical regions. An estimate of the magnitude of thermal stress, which is necessary for design purposes, can be obtained by the analysis of a space frame involving the solution of a

large number of simultaneous equations. This procedure is tedious and time consuming. This paper describes a rapid method of calculation of the thermal stress based on the theory of beams on elastic foundations and illustrates the same by calculating the thermal stress in the 176 ft. high intake tower of Koyna hydro-electric project. The results are verified by model tests and the general applicability and limitations of the method discussed.

PRESTRESSED CONCRETE GROUP

Linear Graph Theory Applied to Structures—1 : Continuous Beams

P. S. Satsangi
Associate Member
and
V. K. Garg
Non-member

This paper attempts to encompass the field of structures in the ever widening fold of the linear graph theory. It presents an application of the linear graph theory for the solution of the problem of a continuous beam on the basis of abstract linear graphs and matrices.

RAILWAY ENGINEERING GROUP

Pile Foundations on the Railways

Kali Charan
Member

This paper describes the salient features of several pile foundations done by the Indian Railways and discusses in brief the preliminary investigations carried out including the driving of test piles, placement of test loads, and determination of the ultimate resistance, allowable load, factory of safety, etc.

Studies in Railway Accidents—3 : Cost of Accidents

T. C. Sarkar
Non-member
and
C. P. S. Ayyar
Non-member

This paper studies the financial loss involved in railway accidents, which is found to comprise direct and indirect costs. It analyzes the elements of the direct and indirect cost of accidents and describes a method for calculating the cost of a railway accident. From a discussion of the data published by the Indian Railways, it concludes that there is no definite mathematical relationship between the direct cost and the indirect cost of a railway accident.

ROADS AND ROAD TRANSPORTATION GROUP

Urban Transportation

P. G. Patankar

Member

The problem of traffic congestion in cities is a global one and it exists in our cities too. The railways gave the nation mobility in the early days. Then came the automobile age and any persons became independent of the public transportation system by owning individual cars. However, the stupendous population concentration and large increase in automobiles are creating a crisis. If the problem of traffic congestion in cities is not solved early, it will raise the question whether a nation born in farms is destined to die in cities. This paper describes the various system of mass transportation and gives a comparative economic survey of them. From a comparison of the overhead rapid transit system with the underground railways, it concludes that the provision of the latter is the only answer to the growing problem of rapid mass transportation.

Drawbacks of Bituminous Mix Design Methods

M. V. Prakasa Rao

Associate Member

This paper describes the requirements for satisfactory performance of a bituminous mix and brings out the factors affecting its performance. The drawbacks of the frequently adopted test of a bituminous mix and the triaxial test, which claims certain advantages over the former, are also discussed. Finally, the method of correlation of these test results with the field performance data of a bituminous mix, which is an an important factor in determining the suitability of the laboratory tested mix, is described.

MECHANICAL ENGINEERING DIVISION

Critical Speed of a Thin Rotating Disc with a Rigid Inclusion Welded at the Centre

K. Chakrabarti

Non-member

Many research workers have worked on the stress-strain characteristics of a thin rotating disc, of both solid and hollow types. Modern workers have also worked on the stress-strain behaviour of both solid and hollow elasto-plastic and plastic discs. They have found the critical speed for which a particular disc undergoes incipient yielding. This paper attempts to show the effect on the critical speed of a thin rotating disc due to a rigid circular inclusion welded at its centre and concludes that for a certain range of the inclusion diameter, there is no critical speed of the disc.

Manufacture of Diesel Locomotives in India

V. A. Patel
Associate Member

This paper studies the different types of locomotives used in railway systems and brings out the superiority of a Diesel hydraulic locomotive over a steam locomotive. It stresses the need for manufacture of Diesel hydraulic locomotives in India and discusses the details involved in the setting up of such a manufacturing plant, *viz.*, selection of site, provision of other facilities, capital requirement, production programme, personnel training, etc.

Analysis of Vibrations in Machine Tools

Dr. A. O. Schmidt
Non-member
and
R. Froumfelkar
Non-member

This paper discusses the numerous causes of vibrations in an operating machine tool. Surface finish of workpiece and its dimensional deviations are often good indications of machine tool disturbances. Torsional vibrations in the drive train of a machine tool are evaluated from the design point of view. A mathematical analysis of an existing design through the use of the Holzer method is carried out. The solutions to these equations are found by the use of an *IBM* 1620 computer. Source of the programming techniques and the values obtained are explained.

Method of Decreasing Dynamic Scatter in Finish Machining Process

S. Somasundaram
Non-member
and
B. K. Paryani
Non-member

The deviation of the size of machined parts may be attributed to periodic and random errors. The first may be compensated by suitable devices if the characteristic is known. But the latter is much more difficult to control. Although there are some methods for limiting the random errors, all of them either lead to a loss of productivity or a loss of the universality of the machine. This paper discusses one method of controlling the random errors in finishing operations.

Rotary Regenerative Heat Exchanger—an Approach to Design for Parallel Flow

Prof. V. F. Stepanchuk

Non-member

Regenerative heat exchangers have served application in practice. A particular feature of this is the steady distribution of temperature in space coordinates, but the temperature of the element itself changes with time with relative motion. These heat exchangers use both parallel and counter flow loops. In this paper only the design method for the parallel flow arrangement is considered.

ELECTRONICS AND TELE-COMMUNICATION ENGINEERING DIVISION

Network Structures for a Special Class of Minimum Biquartic *PR*-Functions

J. G. Advani

Non-member

and

O. P. Gupta

Non-member

Network structures to realize the minimum *pr*-impedance functions were discussed by Valkenburg, Foster, Kim and Seshu. The networks were derived mostly for the simplest form of minimum *pr*-functions, *i.e.*, the minimum functions having zero real part at one frequency. This paper attempts to obtain the network configurations realizing a sub-class of minimum *pr*-functions having zero real part at two frequencies, which are biquartic functions. The basic five-element networks (realizing the minimum biquadratic functions) discussed by Valkenburg are modified to yield the minimum *pr*-biquartic functions having zero real part at two frequencies. Some theorems from the graph theory are used in deriving the modified structures. The networks obtained in this fashion are two 7-element, two 8-element and six 9-element networks. The conditions on the coefficients of a given biquartic function so that it is realizable by the above networks and the values of the network-elements in terms of the coefficients are derived and tabulated.

Synthesis of an A.C. Lead Transfer Function for Minimum Sensitivity by Parallel Ladder Procedure

J. G. Advani

Non-member

and

B. Kesavan

Non-member

The performance of the A.C. system is adversely affected by the changes in either carrier frequency or the notch frequency of the A.C. compensating network. This paper presents a procedure for synthesis is presented that minimizes the changes in the notch frequency, w and defines the overall sensitivity, W_o, with respect to the variations in the various elements of the network.

Transistor Rectangular Pulse Generator

R. R. Mehrotra
Non-member

Harbans Lal
Non-member

and

B. K. Tyagi
Non-member

A new type of emitter-coupler multivibrator, having simply a condenser in the base circuit, has been designed and the performance behaviour has been discussed on the basis of the circuit conditions which made the two transistors alternately conducting and non-conducting. The expressions for the time period for *quasi-stable* states in which transistor X , conducts and transistor X , is cut off and *vice versa* have been developed by taking the charging of the base capacitor due to forward base current and its discharge due to the reverse base current. The circuit is capable of generating fairly suitable symmetrical and asymmetrical rectangular waveforms of quite small rise and fall times, as the signal at the collector of one transistor is not directly involved in the regenerative loop and hence no integrating effect is present in the collector.

Summaries of Papers Published in the Journal, vol. 46, no. 6, pts. EL 3, CH 2 and PH 2, February 1966

ELECTRICAL ENGINEERING DIVISION

A Distortion Eliminator *cum* Distortion Analyzer for Power Frequency Mains Supply

Prof. J. K. Choudhury
Non-member

and

D. P. Chakrabarty
Associate Member

Alternating current commercial supply voltages contain some distortion ; the distortion content generally lies between 4-8%. This amount of distortion is considered to be tolerable for most industrial and domestic applications. However, a distorted supply of this nature is unsuitable for precision electrical measurements purposes. In electrical measurements laboratories, it is necessary to have a power frequency supply source of negligible distortion. To meet this requirement, it is customary for electrical measurements and standardizing laboratories to install a special since-wave alternator together with its driving motor and control accessories. These equipment are expensive and are beyond the scope of small testing laboratories. This paper describes a simple and inexpensive equipment which can eliminate three principal harmonics, say, the third, fifth and the seventh harmonics from a commercial 50-cycles supply source and thereby give an output supply voltage having a distortion content less than 1 %. The same equipment can also be used for measuring the total harmonic content of the commercial supply voltage and can thus serve as a distortion analyzer for the main supply.

Design of an Electronics Voltage Regulation System for Improving Steady State Stability of Power Systems

Dr. M. V. Hariharan

Non-member

and

B. L. Mathur

Non-member

This paper deals with the design and construction of an electronic voltage regulation system which is of the fast and continuously acting type. In a system having a synchronous generator connected through a transmission line to infinite busbars, if electronic voltage regulation system is used to regulate the terminal voltage of the generator. Stable operation beyond the usual steady state stability limit obtained without such regulators is referred to as 'dynamic stability'. It has also been observed that the gain in stability limit above that with close manual regulation increases with decrease in the reactance between the generator terminals and the infinite busbars. An electronic power angle meter has been designed and constructed for accurate measurement of power angle in the dynamic stability region.

Transient Performances of a Saturated Synchronous Machine under Unbalanced Load and Fault Conditions—2 : Solution of Transients

P. K. Mukherjee

Non-member

In this paper, the equivalent circuits involving infinite time harmonics, which have been developed in part 1 of this paper (*vide Journal*, vol. 46, no. 4, pt. EL 2, December 1965) for unbalanced loads and faults on a saturated synchronous machine, are reduced to the equivalent fundamental frequency networks and then, by representing the O.C.C. by Frolich's equaton and alternatively, by a series, analyzed to determine the transients. A few simplified cases have been solved rigorously and a few experimental observations are compared with the theoretical results.

Effects of Short Circuited Coils on the Performance of the Scharge Motor

Prof. C. V. Govinda Rao
Member

Performance characteristics derived from circle diagrams of Schrage machine developed by various authors are unrealiable and erratic even under normal operating conditions. Reasonably dependable results, however, have been obtained from equations of performance in which certain parameters are determined from experimental data. Even these equations are subject to certain limitations prescribed by the different assumptions. One such assumption is the treatment of commutation is a phenomenon that causes sparking and consumption of certain amount of power, which is termed as 'parasitic losses'. This paper develoops accurate expressions for voltages, currents, and torques caused by the coils undergoing commutation and giving experimental evidence in support of the theory. In the process, it is noted that the rotational hysteresis effect is conspicuous and probably necessary to take into account.

Important Aspects of Integrated Systems Operation

S. A. Quader
Member

Rapid inter-connection of system in various regions has already started in the country. This paper deals with the important operating problems involved.

Recent Developments in Biquadratic Immittance Function Synthesis

C. R. Sastri
Non-member

Although certain procedures for the synthesis of the simple biquadratic immittance function have been known since long, a general synthesis procedure that gives a canonic form without using ideal transformers is not yet available. However, recently a number of fruitful efforts have been made to obtain all possible realizations for this simple function for both the minimum as well as the non-minimum cases. A brief account of the various developments in this regard are also presented.

CHEMICAL ENGINEERING DIVISION

Need for Gas Turbine Power Plants in a Refinery

S. K. Goyal
Non-member

This paper deals with application of gas turbine for generation of power in petrochemical industries with special reference to the economics of power generation, cost of operation of steam, Diesel and gas turbine power plants. It also describes the various methods of using gas turbine and brings out the advantage of gas turbine over other types of prime movers.

Metallizing of Structural Steel Work and Its Application in the Pamban Railway Bridge

R. Nagarajan
Associate Member

The steelwork of the girders in the Pamban railway bridge connecting the Indian main land with Rameswaram island across the Palk Strait, consisting of 145 spans of 40-ft. plate girders and one Scherzer lift span of 224-ft., is subject to heaviest degree of corrosion, due to extremely saline atmosphere and spraying of sea water due to waves and heavy winds. Various methods of protection of the steelwork against corrosion at this location have been tried with little success. Recently, the new technique of metallizing was adopted to ensure protection for new steel work of girders of the Pamban railway bridge, and this paper describes the theory and practice of metallizing with aluminium and zinc with special reference to this work. It also discusses the economic aspects of the above technique, which is likely to be increasingly employed for the protection of steelwork in railway girders agaist corrosion under similar conditions, in the years to come.

An Unusual Pollution of Water in Kidderpore Docks

S. B. De
Non-member
and
I. Radhakrishnan
Non-member

This paper describes a novel experience in water pollution in Kidderpore docks, which was attributed to the ingress of can sugar and presents the measures undertaken to combat this pollution together with the analysis reports on samples of water collected over a period of one month. The results indicate that the original conditions were restored after nearly a month.

Evaporation Control by Use of Monomolecular Films and Experimental Work done at Vehar Lake

S. R. Kshirsagar
Associate Member

Suppression of evaporation from water supply reservoirs is a very important means of water conservation in hot and arid regions of the country. This paper explains the theory of evaporation and discusses the method of evaporation control by the use of monomolecular films formed on the water surface employing long chain falty alcohols. It also describes the actual work done and the evaporation suppressed in April—May 1965 at the Vehar Lake of the Bombay Municipal Corportion, which supplies about 20 milliongallons per day of water to the city. The results obtained in this work conclusively show that this method of evaporation control is feasible and can be used profitably in case of small shallow reservoirs in our country to conserve water and make it available to the public in need.

Some Aspects of Economy in Sanitary Plumbing 1—Intercepting Trap

R. C. Singh
Associate Member

This paper critically analyzes the need for providing an intercepting trap on the drain connecting a house with the municipal sewer, and concludes that interceptors are not only avoidable but also undesirable devices. It strongly recommends a revision of the bye-laws which stipulates the provision of interceptors in sewers.

Hydrogen Sulphide in Concrete Sewers and Digesters

G. J. Mohanrao
Associate Member
C. A. Sastry
Non-member
and
W. F. Garber
Non-member

This paper discusses the basic mechanism of hydrogen sulphide production in sewage with special reference to the effect of temparature, strength of sewage, velocity of flow, age of sewage, *pH* value sulphate concentration and ventilation; and suggests control measures, *e.g.*, proper design of sewers, sewage composition, cleaning of the sewers, use of chemicals and various materials of sewer construction and lining. The minimum sewage velocities required under the various conditions are tabulated with reference to the values of effective B.O.D. It discusses briefly the hydrogen sulphide generation in sewage sludge digesters and its removal from digester gas.

INSTITUTION NOTICES

Draft Indian Standards

The following Draft Indian Standards have been issued recently.

1. Draft Indian Standard Specifications for Tool and Die Steels for Cold Work—Doc. SMDC 19(682).

This Standard covers the requirements for plan carbon and alloys tool and die steels in the form of bars, blanks, forging rings and their shapes for cold work, capable of being hardened and tempered.

2. Draft Indian Standard Specification for Flame and Induction Hardening Steel—Doc. SMDC 19 (692).

This Standard covers the requirements for wrought alloyed and unalloyed steels for flame and induction hardening.

Members may send their comments on these Draft Standards before March 15, 1961, to Dr. G. P. Chatterjee, M.I.E., Chief Metallurgist, Durgapur Steel Project, Durgapur, who is the Institution representative on the Sectional Committee dealing with these Standards.

Copies of the draft Standards may be obtained from the office of the Indian Standards Institution, 'Manak Bhavan', 9 Bahadur Shah Zafar Marg, New Delhi 1, or from its branch offices at Bombay Mutual Terrace, Sandhurst Bridge, Bombay 7; 5 Chowringhee Approach, Calcutta 13; 14/69 Civil Lines, Kanpur; or 54 General Patters Road, Madras 2.

Letter from Dr. G. P. Chatterjee, Chairman, Mining and Metallurgy Division, to members

Dear Corporate Members,

As some of you know the Mining and Metallurgy Group has now been raised to the status of a Division under the new Bye-laws of the Institution of Engineers (India). This has been done with a view to expand the activities in the field of Mining and Metallurgy, which, you will agree, has assumed in recent years great importance particularly in the present context of planned development of the country.

We are addressing personally on this matter seeking your help with regard to contributing some good papers in the Mining and Metallurgy Division Part of the *Journal*.

May I also seek your help in enrolling new Members in this Division?

I have no doubt in my mind that with your help and cooperation this Division will be able to extend its activities and services to the Members.

Yours faithfully,
(Sd.) G. P. Chatterjee
Chairman
Mining and Metallurgy Division

INSTITUTION NEWS

Shri Deb Kumar Ghosh

Shri Deb Kumar Ghosh, B.E., C.E., D.T.R.P., A.M.I.E., now the Deputy Secretary of the Institution, was born in Calcutta in 1926, and inherited the hall-mark of high education from the ancestry of both the parents.

Educated at the Ballygunge Government High School and the Presidency College, Calcutta, Shri Ghosh pursued studies in civil engineering at the Bengal Engineering College, Sibpur, and obtained the Bachelor of Engineering (B.E.) degree of the University of Calcutta in 1949. He also took the post-graduate Diploma in Town and Regional Planning, awarded by the University of Calcutta, as a student of the same college.

Shri Ghosh started his employment career in 1950 as an Assistant Engineer in the Works and Buildings Department (presently the Public Works Department) of the Government of West Bengal. In 1956, he proceeded to the U.K. and worked with McCalls Macalley, Ltd., of Sheffield, who were the proprietors of the Lee-McCall system of Prestressed Concrete. The same firm subsequently selected him as their representative in India, and for five years thereafter, he strived for promoting and popularizing the use of prestressed concrete, especially the Lee-McCall system, in India, through his services with The United Steel Companies (India), Private Ltd., and the I.R.C. Weldmesh, Ltd. During this period, he undertook extensive tours in the different parts of India and also visited the U.K. for a short period.

Besides this, Shri Ghosh has acquired wide experience in the design and construction of R.C.C. and prestressed concrete bridges and precast concrete units, through the intensive association with his illustrious uncles, Shri S. K. Ghosh, B.E., A.M.I.E., Chief Engineer, Public Works (Roads) Department, of the Government of West Bengal, and Shri K. P. Roy, B.E., M.I.E., Director-in-Charge, Chanda Engineers (India), Ltd.

He joined the Institution as a Student Member in 1948; and was subsequently elected as an Associate Member in 1956. He is also a member of the Indian Roads Congress, the Prestressed Concrete Development Group, and the International Association for Bridge and Structural Engineering.

Shri Ghosh has joined his office on December 18, 1965.

Mysore Engineers' Association Centenary Lecture

The Second Mysore Engineers' Association Centenary Lecture was delivered by Shri N. N. Iyengar (*M.*), Retired Chief Engineer and Former Electricity Commissioner, Government of India, on the occassion of the 31st Annual General Meeting of the Mysore Centre held on December 23, 1965. The subject of the Lecture was 'Some Priority of Electricity Utilities'.

Transactions of the Sectional Meeting of the World Power Conference, Lausanne, 1964

The Swiss National Committee have decided to sell single volumes also of the *Transactions* a complete set of which consists of seven volumes. The cost of a single volume is Fr. 130 (Swiss) including packing and postage by surface mail to any destination. Orders may be sent through the Headquarters Office of the Institution which is the Indian National Committee for the World Power Conference.

Asian Summer Institute of Water Supply and Treatment, March 14-May 20, 1966

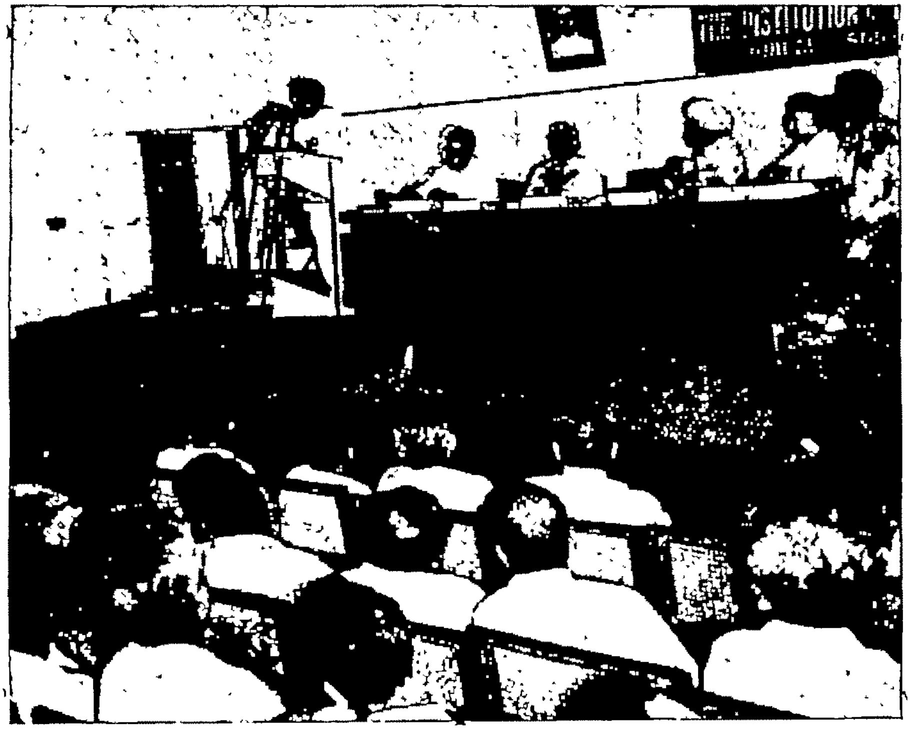
The Asian Summer Institute of Water Supply and Treatment, sponsored by the SEATO Graduate School of Engineering in cooperation with the Ministry of Public Health of Thailand, the U.S. Agency for International Development, Department of Sanitary Engineering, Chulalongkorn University, will be held in Bangkok from March 14 to May 20, 1966. This Institute offers courses in the following subjects: (i) Water Supply Engineering, (ii) Unit Processes in Water Treatment, (iii) Chemistry and Microbiology of Water Supplies, and (iv) Water Supply and Treatment System Design. The courses will be of 10 weeks duration and the programme has been designed to enable participants to discuss freely their individual-problems as well as to bring the up to date with the latest developments in this field.

Further details can be obtained from Prof. M. B. Pescod, SEATO Graduate School of Engineering, P.O. Box 2754, Bangkok, Thailand.

LOCAL CENTRE ACTIVITIES

Bhilai Sub-Centre

The Fourth Annual General Meeting of the Bhilai Sub-Centre of the Institution was held on April 3, 1965. Shri P. C. Sethi, Union Deputy Minister in the Ministry of Steel and Mines, was the Chief-Guest. The Chief-Guest in his inaugural address dealt with the role of the engineer in the Fourth Five Year Plan. He traced the growth of civilization and development of communications. He said that inventions were spreading at a faster rate by space travel which would alone judge the advancement of science and technology. He also said that in 1964 there were 131 technical institutions in the country with an intake capacity of 23,000 engineering students and by the end of the Third Plan this was raised to 25,000. During the course of the Fourth Plan the annual turnover would be 34,000. He reminded his audience the duty of the engineer in raising the standard of the masses, the full efficiency the country was expecting of him and in avoiding wastes.



SHRI P. C. SETHI, UNION DEPUTY MINISTER, (CHIEF GUEST) IS ADDRESSING THE MEETING

Shri Indarjit Singh, General Manager, Bhilai Steel Plant, also addressed the meeting. He said, 'Professional responsibility, ethics and reward can be achieved only by systematic hard work and by continuous acquisition of knowledge. Systematic hard work, in this age of rapidly advancing sciences, has a complex meaning. In fact, an engineer is a part of a very complicated organizational structure these days and has to imbibe fully what management experts call the activities of the entire organization, its decision making apparatus and its relationships. He can only contribute his 'added value' to tasks if he is conscious of these matters and contributes rationally to their simplification but avoids shouting at them. Then it is necessary for him to keep in touch with the progress of pure sciences, underlying his profession, and advanced professional and managerial knowledge. What has struck me most in big industrial complexes in India is the difference which is artificially created between the practical and the theoretical and between the experienced and the inexperienced. In fact, what is the theory of today is the practice of tomorrow and it becomes so by the willingness of the so-called practical persons to experiment with new ideas, experience is very important for man management, supply management and for solving repetitive problems but new knowledge is required for introducing the latest work in science and technology. The brighter and the more industrious of the younger generations, bring new knowledge into focus. I remember 'tensors' and 'matrices' were distant dreams in my times but they are a part of middle level algebra in these days'.

Roorkee Sub-Centre

The Fourth Annual General Meeting of the Roorkee Sub-Centre was held in the Senate Hall of the University of Roorkee on November 28, 1965. Prof. N. S. Govinda

PROF. N. S. GOVINDA RAO (CHIEF GUEST) IS ADDRESSING THE MEETING

Rao, President, was the Chief-Guest. Shri Dinesh Mohan, Chairman of the Sub-Centre, in his address dealt with the subject 'Research and Development in Building Industry'. While pointing out the scarcity of construction materials and with their use in the building industry, he emphasized the need for research on both the conventional materials and the new ones like plastics. He added that substitution of scarce materials like steel and cement by timber and lime respectively also requires consideration. After his address, the Chairman introduced Prof. N. S. Govinda Rao, to members and requested him to inaugurate the meeting.

Prof. Govinda Rao in his inaugural address stated that engineers should come forward to become members of the legislatures, parliament or ministries and as head of manufacturing concerns and the chief engineers should act as secretaries to the government. He also said that the expertize available in the country should be made use of by the government in place of the consulting services from abroad and engineering graduates should come forward in large number to serve in the armed forces.

Dr. A. S. Arya, Hony. Secretary of the Sub-Centre, proposed a vote of thanks to the Chief Guest and other invitees and the meeting came to an end.

At the technical session then followed three papers were read and discussed, *viz.*, (i) 'Free Surface and Seepage Face around Pumped Levells' by Prof. S. N. Gupta, (*M.*), S. P. Sangal (*Non-member*) and Anil Kumar (*A.M.*), (ii) 'Foundation of Tall Circular Structures' by A. S. Arya (*A.M.*) and (iii) 'A Contribution to the Determination of Universal Machinability Index' by G. S. Sekhar (*Non-member*) and Dr. R. K. Suri (*Non-member*).

FORTHCOMING CONFERENCES

Symposium on 'High Velocity Flow', Bangalore, 1966

A Symposium on 'High Velocity Flow' will be held at the Indian Institute of Science, Bangalore, by the end of the year 1966. The topics proposed to be covered include, (i) Air entertainment at high velocity in chutes, nozzles, expansions contractors, bends, etc. ; (ii) Energy dissipation of high velocity flows ; (iii) resistance of body shapes to high velocity flows ; (iv) Cavitation in hydraulic machines and structures ; (v) Experimental techniques in high velocity flows ; (vi) Movement of sediment in high velocity flows ; (vii) Friction and resistance under high velocity flows in bends, expansions, contractions and other obstructions in closed conduits and in open channels ; (viii) Waves and surges in high velocity flows ; and (ix) Other allied subjects.

Papers are invited for presentation and discussion at the Symposium. Further details may be obtained from Prof. K. Seetharamaiah, Civil and Hydraulic Engineering Department, Indian Institute of Science, Bangalore 12.

International Seminar on 'Automatic Control in Production and Distribution of Electrical Power', Brussels, April 18-22, 1966

An international Seminar on 'Automation Control in Production and Distribution of Electrical Power' will be held in Brussels, Belgium, from April 18 to 22, 1966. The aim of the Seminar is to strike the balance of the contribution of automation techniques to operation reliability, and to power production and distribution optimization, by an international meeting of automation specialists and power utilities staff. The subjects to be discussed at the Seminar and broadly classified as follows :

The Automatic Control in Electrical Power Production :

Dynamic behaviour of steam generators (boilers, nuclear reactors)

Automatic Control of steam generators (boilers, nuclear reactors)

Automatic start-up procedures

Automatic Control of turbo-generator sets

Utilization of computers for purposes of supervising, performance evaluation and automatic monitoring of power generation units

Utilization of computers for purposes of supervising, performance evaluation and automatic monitoring of power generation units

Automatic Control in Electrical Network Operation :

Automatic allocation of power production

Automatic control of transmission networks

Further details can be obtained from Administrateur-Seceretaire, Institut Belge De Regulation Et D'automatisme, 3 Rue Ravenstein, Bruxelles 1, Belgium.

International Congress and Exhibition on 'Instrumentation and Automation in the Paper, Rubber and Plastics Industries', Antwerp, October 24-28, 1966

The Technologisch Instituut van de Koninklijke Vlaamse Ingenieunsvereniging in cooperation with the Belgisch Instituut voor Regeltechniek en Automatizering' is organizing an international Congress and Exhibition on 'Instrumentation and Automation in the Paper, Rubber and Plastic Industries' to be held in Antwerp, Belgium, from October 24 to 28, 1966. The purpose of the Congress is to give a survey by means of lectures, discussions and an exhibition of the new techniques and instrumentation and quality control in the paper, rubber and plastics industries. The Congress will deal with the following subjects : (i) The measurement and automatic control of physical parameters involved in the manufacture of rubber and plastics, (ii) Possible application of automatic computers in the manufacture of paper, rubber and plastics, and (iii) Measurement techniques for quality control and scientific research.

Further details can be obtained from the Secretary's Office, P. R. P. Automation, Ingenieurshuis, Jan van Rijiswikcklaan 58, Antwerp, Belgium.

BOOK ACKNOWLEDGMENTS

1. Lining of Earthen Irrigation Channels. H. L. Sally. *Asia Publishing House*, Bombay, Rs. 15.00. 109 pages.

Lining technique, as generally adopted in various projects in India, have been discussed and details of construction made explicit. Economic suggestions have been made for substituting some of these by methods equally, if not more efficient. These are based on experimental results available from various laboratories mentioned in the text and in the author's own sphere of influence. Practical difficulties in implementing some of his recommendations in the field may be there till the ingenuity of technicians comes to the help of engineers.

2. **Principles of Perspective Drawing.** M. G. Shah and C. M. Kale. *Asia Publishing House*, Bombay, Rs. 10.00.

In this book the principles of perspective drawing are explained in a precise manner. The book is meant for the use of students of engineering, architecture, and draftsmen, practising engineers and contractors.

3. **Multi-Chart for Multiplications, Divisions, Squares, Cubes and Charts for Conversion of Units.** B. R. Nagbhushana Gupta. *The Engineering College Cooperative Society Ltd.*, Bangalore, Rs. 2.50.

Useful nomograms have been given to this book for those who have to deal extensively with the conversion of values from F.P.S. to M.K.S. units, specially mathematicians, physicists, accountants, businessmen, and others will find many of these very useful. Charts pertaining to simplification of calculations for the design of structures and determination of hydraulic data will be of great utility to practising engineers.

4. **Introduction to Foremanship.** R. Banerjee. *The World Press Ltd.*, Calcutta, Rs. 5.50, 127 pages.

The book covers the syllabus of 'Foremanship' for the mechanical students pursuing diploma course in polytechnics. Various provisions of the different 'Industrial Acts' have been included. Worked out problems have been incorporated to guide the readers. The book will be useful to the practising foremen and junior executives engaged in industry and apprentices in industrial establishments.

5. **Labour Relations.** R. B. Gupta. *Saroj Prakashan*, Allahabad, Rs. 3.50. 152 pages.

This book is intended to meet the requirements of diploma students of engineering and technology of the various State Boards of Technical Education. The subject matter in the book has been dealt with lucidly.

6. **The Measurement and Suppression of Noise.** A. J. King. *Chapman and Hall Ltd.*, 40s. 180 pages.

An introduction to the human auditory system have been given in the first part of the book. Objective and subjective methods of noise measurement, calculation of loudness levels from analyses, vibration and the human response to vibration are explained. Part two of the book deals with the radiation of noise from machines, reduction of noise at the source and in transmission. Finally, the author examines the problems of installation of machines in buildings. The book will be of use to architects, physicists, and/engineers of all types. Theoretical issues have been illustrated with practical problems. The book will be of help not only to those concerned with the challenge of design, but also to those taking university courses in applied acoustics.

7. **Basic Electronic Circuits—1.** *Asia Publishing House*, Rs. 22.50.

The presentation of every circuit described, wherever possible has been formalized. A page illustrating the circuit diagram of the basic circuit of the 'family' and the voltage waveforms which that circuit produces, is followed by a detailed description of how the circuit works by one or more further pages illustrating practical circuits of the type in question. Most of the circuits presented have been described and illustrated in both their valve and transmitter forms.

8. **The Dynamic of Linear and Non-Linear Systems.** P. Naslin. *Blackie and Son Ltd.*, London, £ 5.5.0, 586 pages.

The book is based on the fundamentals of electrical circuit theory after the analogies between different control systems have been shown. The treatment of the linear theory is better balanced, and has been well illustrated by examples. The author has developed his own damping criterion for control systems which is easy to grasp. Sufficient non-linear theory is included for most practical purposes without resort to the highly mathematical techniques which are not yet of much of practical value.

PUBLICATIONS RECEIVED

A copy of a booklet entitled 'Structural Engineering Research Centre' has been received from the Director, Structural Engineering Research Centre, Roorkee. This booklet gives details of the Structural Engineering Research Centre recently set up by the C.S.I.R. at Roorkee, and the laboratory facilities available therein.

A copy of a publication entitled 'Symposium on the Application of Prestressed Concrete to Machinery Structures' has been received from the Prestressed Concrete Development Group, Terminal House, Grosvenor Gardens, London, S.W. 1. The Symposium was conducted in London, from January 14-15, 1964. The papers are on the following topics : (i) Prestressed Concrete and its Relevance to Machine, (ii) Local and Bearing Stresses, and (iii) Application of Prestressed Concrete to Machinery Structures. The cost of the publication is 25 s.

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, industrial and other organisations employing engineers. It is hoped that the employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

SITUATIONS WANTED

AN ENGINEER, L.E.E., Grad. I.E. (India), having 10 years experience in designs, sales project, specifications, manufacturing, development in various electrical-mechanical machinery, *i.e.*, transformers (10,000 kVA), motors, switchgears, rectifier, electrodes, structurals, etc., seeks immediate change in Calcutta or Bombay. (Office ref. E.S. 216)

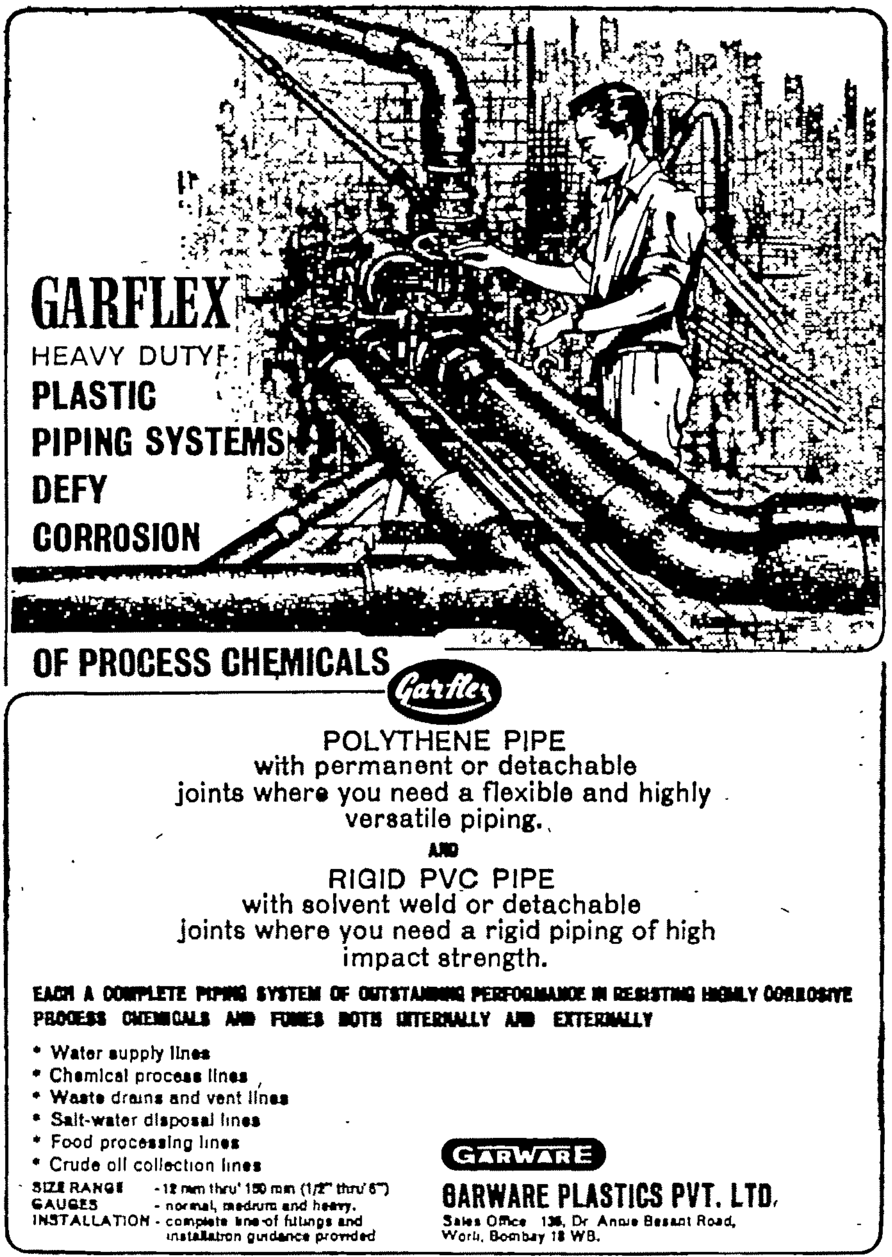
N. DAS GUPTA, B.E., C.E., M.S.(Minn.), M. Am.Soc., C.E. (U.S.A.), M.I.E. (India), Civil Engineer, Retired Principal, Assam Engineering College, Gauhati, and Dean of the Faculty of Engineering, Gauhati University, will be available for consultation for planning, design and valuation of buildings; design of dams and other hydraulic structures; foundation engineering; planning of flood control and drainage works, etc., from the 15th February, 1966. Write to: Twin Cottage-South, Peppe Road, Ranchi, Bihar.

A.M.I.E., more than 15 years experience in valuation of properties land acquisition, city planning, site planning, town planning schemes and all the matter concerning town planning at present occupying highly responsible position seek change. (Office ref. E.S. 217).

ELECTRONICS ENGINEER, age 31 years, passed Sections A and B in Electronics and Telecommunication branch, having nine years experience in installation, maintenance and repairs of airborne radio and radar equipment, presently employed as instructor, seeks change. Salary expected Rs. 500. (Office ref. E.S. 218)

ELECTRICAL ENGINEER, Student of the Institution of Engineers (India), experienced in installation and maintenance of electrical gears, having over 20 years experience in the line, and holding electrical supervisor's certificate of competency for H.T. equipments excepting lifts and electrical signs, presently employed in a tobacco industry near Delhi, seeks change with headquarters at Calcutta. Salary expected near Rs. 800. (Office ref. E.S. 219)

CIVIL ENGINEER, Grad. I.E., 31, passed civil overseer examination with 77% marks and Sections A and B of the Associate Membership examination of the Institution of Engineers (India) in civil engineering subjects, having 7½ years experience out of which 2½ years in a responsible post. At present Assistant Engineer in a Development Body and acquainting the duties of designs of buildings including multistoreyed RCC frames, preparation of estimates, supervision of construction of buildings, roads and other allied engineering works. Present salary Rs. 410 seeks suitable change in Government undertaking or private construction company of repute at Delhi or in its vicinity. (Office ref. E.S. 220).



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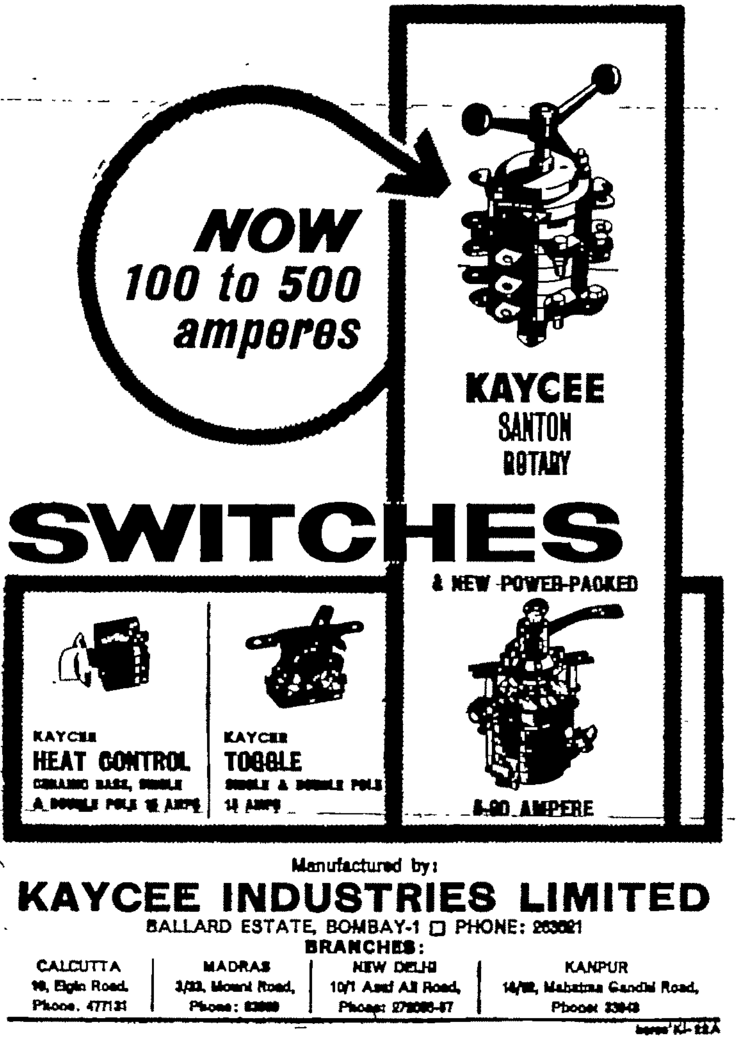

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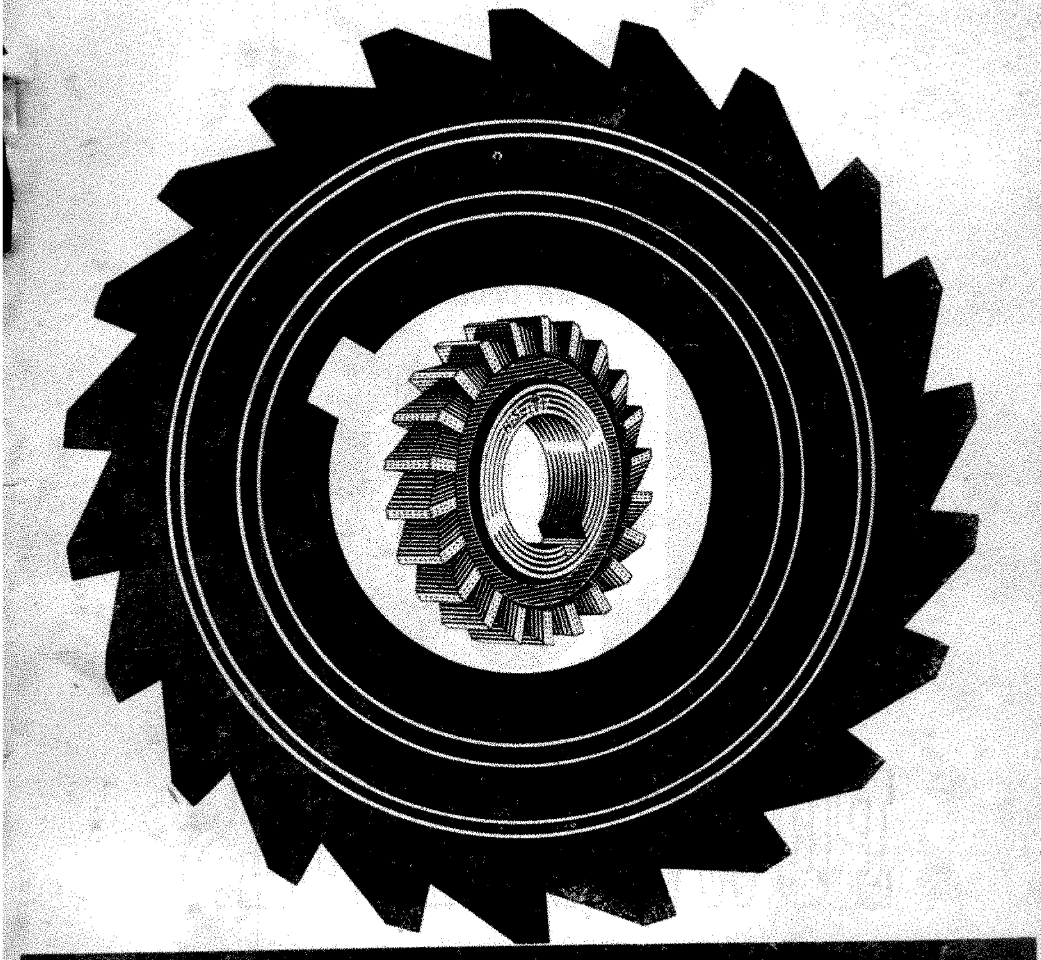

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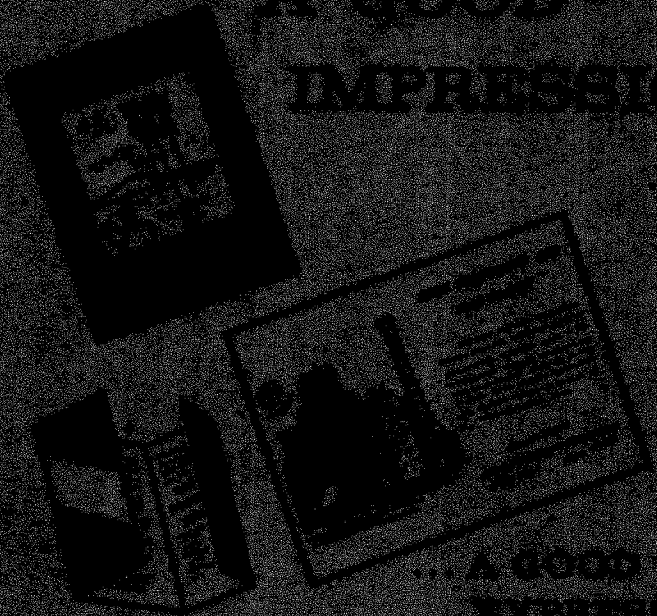

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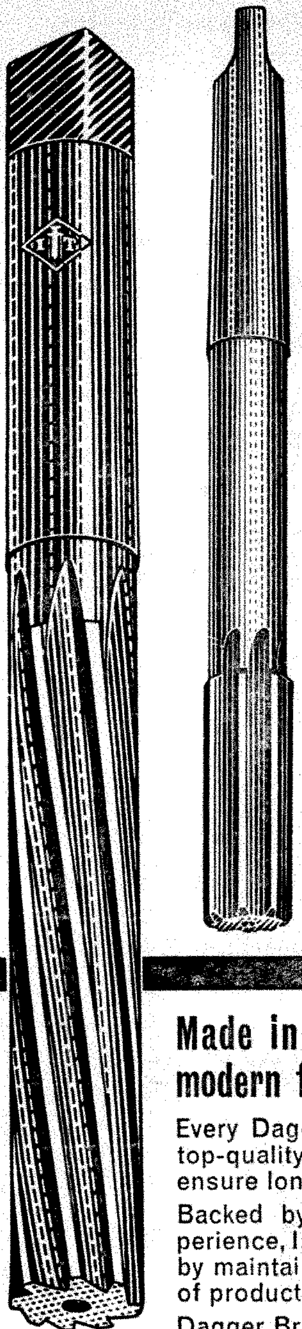

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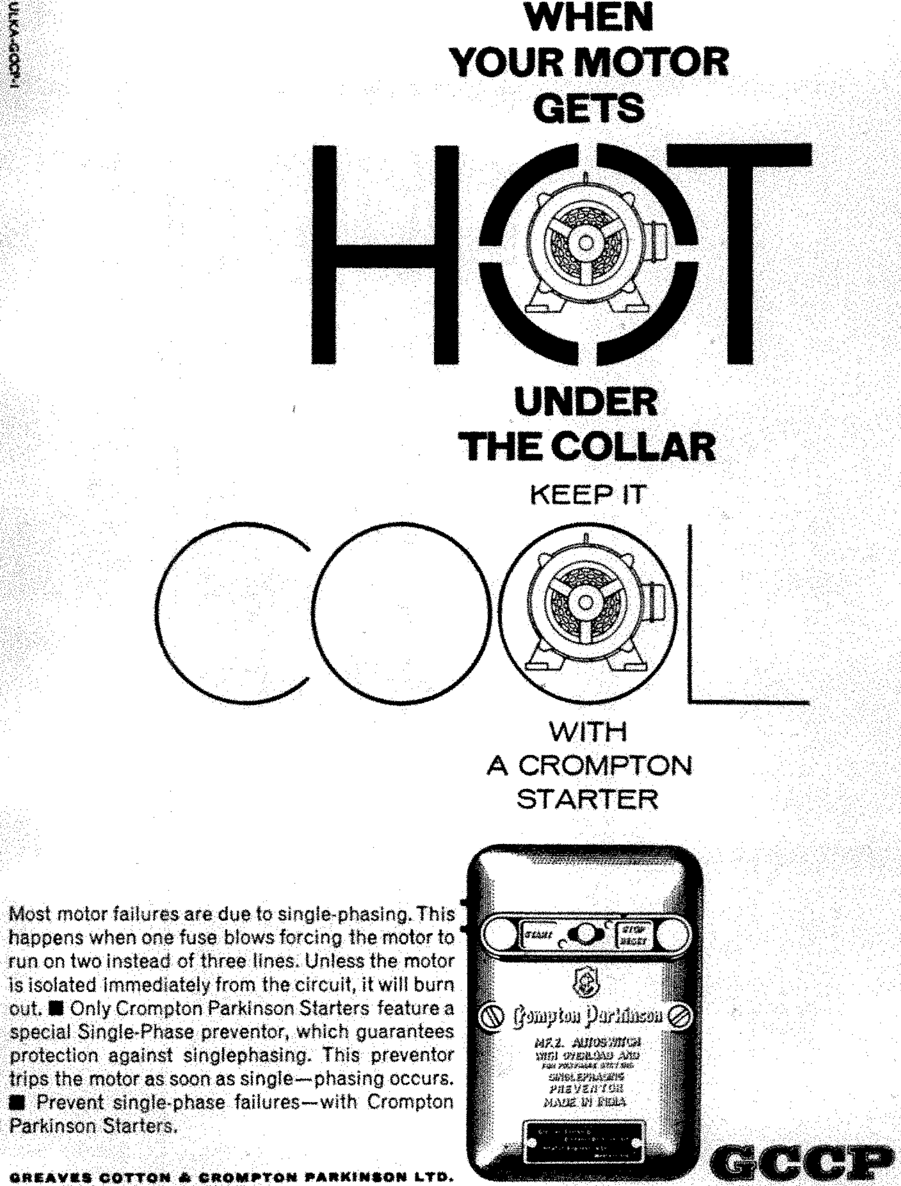
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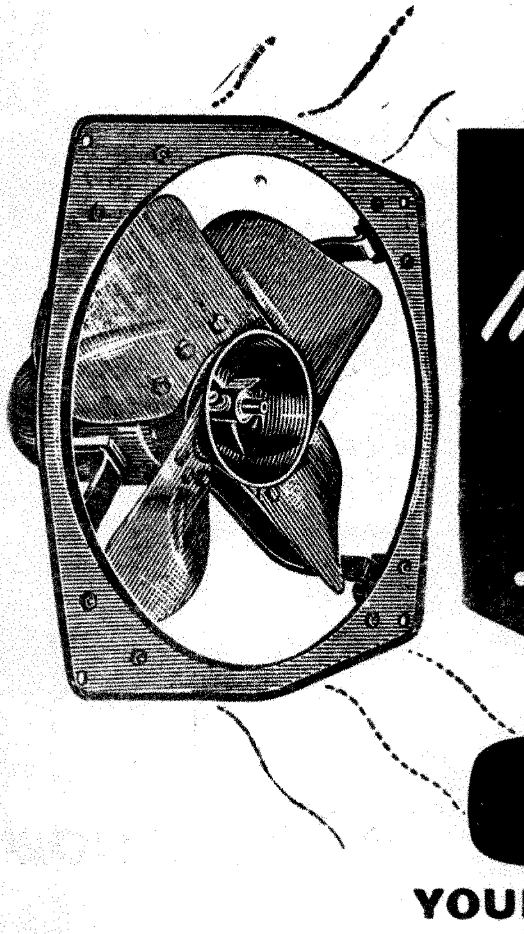

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VARIETY REDUCTION—AN AID TO HIGHER PRODUCTIVITY

B. S. Ganesh

Non-member

Introduction

In the olden days we used to hear the proverb 'variety is the spice of life' and people preferred a large number of varieties of goods starting from food and cloth to equipments. As the days pass ideas sometimes change and now people prefer to reduce varieties. This idea of variety is based on scientific reasoning to increase productivity and hence this idea is more or less a permanent one. Productivity is basically defined as the ratio between output and input and may be called as efficiency. Hence as the constant endeavour of everybody is to increase efficiency, so is the productivity.

Productivity is key to plenty and door to prosperity in an industrial economy This is true to the population of a nation irrespective of whether they are share-holders, executives or workers. In this paper, an attempt has been made to explain briefly the effect of variety reduction on productivity to any country in general and our country in particular, as our country needs higher productivity to increase the standard of living by increasing the purchasing power of our earnings.

Some feel that benefits of variety reduction is applicable only in the engineering field for components, raw materials, and products, but in this paper it will be shown that benefits of variety reduction can be applied to the main resources of the industry, namely, materials, machines and men.

Variety reduction is described as the process of eleminating all the unnecessary diversity which frequently exists in the various stages of design, manufacturing, purchasing, selling, etc. This may be in respect of quality or size.

Variety reduction process is governed by customer willingness to buy and this is conditioned by quality, style, performance, appearance, etc. As all customers are not alike, so their likings. So varieties may be necessary to have good sales. Still of all the factors which affect the customers' willingness to buy, price is the important factor and any reduction in manufacturing, selling and overheads, etc., tends to reduce the selling price of the product. This reduced selling price has a good effect on sales. Substantial reduction in cost and increase in productivity can be obtained by reducing the varieties of products. A few cases are discussed below.

Materials

1. *Design stage*

Designs and drawings are the fundamental requirements for the manufacture of any component or product. Design and drawing office is the first place where product and its various components, raw materials, tolerances and so on are thought of. Considerable amount of man hours, stationery and other allied things are spent on each item. If the variety of components, raw materials, etc., are numerous time and effort spent will also be more and the number of designs and drawings prepared per day per man will be less. Thus, the productivity of design and drawing office suffers and the cost of the products get increased. If the number of varieties of components are more, then the drawings and other relevant documents required are more and more number of costly cabinets and valuable storage accommodation will be required. This again increases the overhead expenses which again tends to increase the selling price of the product.

2. *Manufacturing stage*

If the number of varieties of components are decreased, the quantity per batch can be more. Hence there will be lesser proportion of the set up and dismantling time when compared to the manufacturing time. Thus productivity of manufacture increases, and the manufacturing cost per unit decreases, and is shown in Fig. 1.

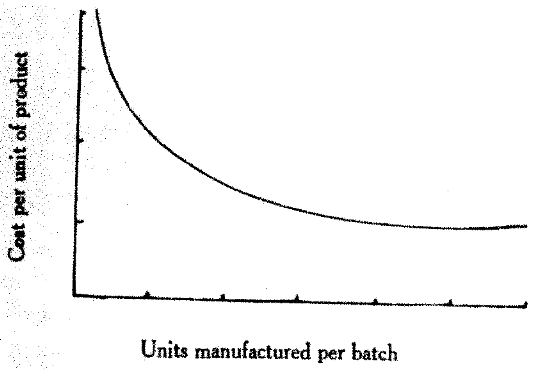

Fig. 1

Cost per unit of product *vs.* units manufactured per batch

As the batch content is increased, number of batches of components and assemblies required for a certain number of products will be reduced. This reduces the number of work orders, job cards, material requisitions, stores delivery challans and other documents. Thus the overhead charges on manufacture will also decrease.

By increasing the batch content, the number of components, assemblies, and products manufactured per machine per unit time, and per man per unit time gets increased. This in turn increases the productivity of man and machine, and also tends to decrease the manufacturing cost.

3. *Estimating and accountancy stage*

If the varieties of items are reduced, number of separately priced articles will be reduced, and the work of estimating and accounting will naturally be reduced. If one article were purchased at a certain price, virtually no effort would be required for estimating and accounting, as mere multiplication would be sufficient. But if there are several varieties of the same item, differing in rates also, the effort in estimating and accounting goes up tremendously to increase the overhead expenses. The situation is shown graphically in Fig. 2.

Naturally when estimating and accounting costs are increased, due to a large number of varieties, quantum of estimating and accounting work done per man per day will be less and the overall productivity suffers.

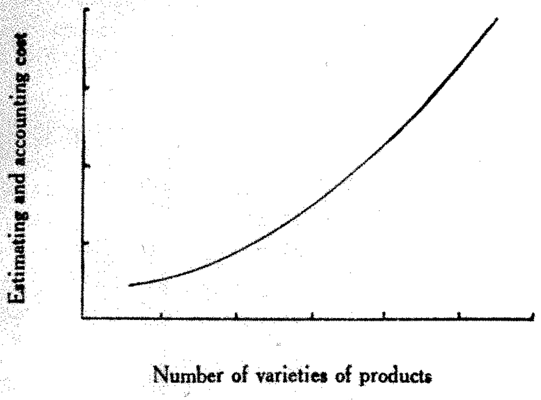

Fig. 2
Estimating and accounting costs *vs.* number of varieties of products

4. *Sales stage*

Sometimes a few salesmen and a few people who do not know the implications of the varieties, feel that sales work would be easier if more varieties are available. But this is a wrong notion and the reasons are :

(i) If the varieties are less it would be easier to concentrate on sales efforts ; and

(ii) If the varieties are large, much time would be spent by the sales staff in demonstrating the different varieties to the best satisfaction of the customer, and still he may not buy. Thus, the quantum of sales done per man per day is less and the productivity of sales staff will be decreased. We generally come across the situation of a large number of varieties at the time of purchasing cloth. Effect of more number of varieties is explained in Fig. 3.

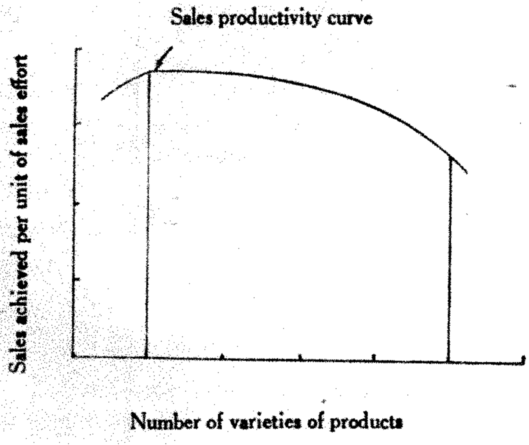

Fig. 3
Effect of more varieties on sales

It may be easily observed from the curve that sales productivity decreases when the varieties increase, and will be maximum at a certain range near where the curve tends to be a straight line parallel to the variety-axis.

5. *Purchase stage*

Purchasing function will be made considerably easier by the reduction of varieties in respect of the following.

(i) Issue of enquiries,
(ii) Opening of tenders, scrutinizing and choosing,
(iii) Issue of purchase orders, and
(iv) Follow up of purchase orders.

A few typical instances are given below.

If the number of varieties are reduced to a certain figure the quantity per item of the reduced figure increases, and so, instead of placing more number of orders for lesser quantity of each variety, the buyer will place lesser number of orders for more quantity of the reduced number of varieties. As generally productivity of the buyer is judged by the average monetary value of the orders issued per day, in certain categories of supplies, productivity of the buyer gets increased, if the varieties are less. This means productivity of the organization as a whole gets increased, and the cost of the product tends to decrease.

Variety reduction in addition to having the beneficial effect on the buyer, has advantages on the supplier and the transport undertaking. Thus, (i) as the quantity involved is more, there might be competition among the suppliers and materials may be purchased at lower rates and cost per unit gets reduced. In case the suppliers have to specially manufacture the items, their batch quantity also gets increased, and their cost of production per unit of item also gets reduced. Thus productivity of the supplier also increases, and (ii) as the quantity of each variety increases, transportation cost per unit comes down as bulk quantities have cheaper rates than small quantities. Thus productivity of the transport company also gets increased.

6. *Stores stage*

One important department wherein the harmful effect of a large number of varieties is felt is the stores department, because in most other departments effect of varieties are felt on paper, whereas in the stores department effect of varieties is found both physically and on paper. This harmful effect presents a lot of problems and adversely affects the productivity of the stores department. A few examples of this phenomenon are cited below.

(a) *Paper work*: There should be as many ledger cards, receipt vouchers, and other documents as there are varieties of items. So, if the varieties are decreased, there will be definite savings in paper work in addition to savings in valuable time.

(b) *Storage*: If the number of varieties are more there is need for separate racks so that one variety may not be mixed with the other. This involves investment in the racks and floor space. If the varieties are less, investment in racks and floor space is reduced and the overhead expenses becomes low.

(c) *Inspection*: In the inspection of incoming stores also, same analogy of mass production holds good. If the varieties are more then, naturally, the quantity per variety would be smaller and much of unproductive time would be taken when compared to larger quantities and lesser varieties.

Machines

Principles of variety reduction can be applied to plant and machinery also, and even in this case, we may observe that lesser the varieties of machines more the productivity, and a few examples are given below.

(a) *Spare parts*: If the varieties of machines are less, then only a few types of spare parts can be stocked, thus avoiding investment, and other stores problems. Besides this, maintenance of plant and machinery could be efficient.

(b) *Training*: If the number of varieties of machines are less, training of operators will also be easy. If an operator of any machine absents, another operator can handle the machine without spending much time. Productivity of the worker gets increased.

Men

Variety reduction can also be applied to human resources in industry. This does not mean that heights of persons are to be limited or weights are to be limited or employees of different casts and creeds are to be discouraged. But the grades, terms of appointment, designations and so on are to be restricted to the minimum, and they are to be in reference to the defined responsibilities, qualifications and experience as far as possible. If the varieties of grades, terms of appointments, designations, responsibilities, etc. are numerous, employees cannot be guided by uniform policies. This may lead to conflicting situations, discontentment among the employees, lot of unnecessary representations and un-productive work. This leads to decrease in productivity.

Variety reduction can be applied in the field of agriculture also, and we will find increase in productivity.

Conclusions

From the above, it may be inferred that reduction in the varieties leads to increase in productivity of the industry, which is again linked with the productivity of the Nation. If the productivity of the Nation gets increased, purchasing power of our earnings goes up and there will be no need for agitations for more pay. Hence, the author wished that in view of the keen necessity to increase our national productivity, principles of variety reduction may be applied as one of the tools of management.

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PERSONNEL FOR INSTRUMENTS INDUSTRY

K. Ray

Member

Introduction

Manufacture of scientific instruments has made some headway in the last few years. But more than half of our requirements are still being met by imports. We are importing scientific instruments to the tune of Rs. 8 crores a year and producing about Rs. 5 crores worth. We are also exporting instruments amounting to a few lakhs of rupees. We have some 50 organized manufacturing establishments, and over 300 small scale units. All the 300-350 small scale units put together handle only a fifth of the total value of instruments produced in the country.

The progress in this vital field is not fast enough. The plan target of instruments production was set at Rs. 25 crores a year by 1966. Assessment however shows that actual production may not exceed Rs. 10 crores.

The dearth of qualified instrument technologists and technicians is often said to be the major deterrent to the development of the instruments industry in the country. A closer look, however, indicates that dearth of trained personnel is not the real handicap.

Place of formal qualification

Much has been made of non-availability of trained personnel in the field. It is true that instrument engineers and technologists are a rare commodity in the country and their number does not exceed 300. Yet they are not very much sought after by the manufacturers of instruments.

Seventy percent of our graduates in instrument engineering or technology have found employment in various industries like steel, fertilizer, chemicals, sugar, rayon, etc. They are working as instrument engineers or instrument foremen, and their duties are to operate and maintain the industrial and process-control instruments in use. Another 15% are divided between educational and research institutions, and in sales and service departments of the instruments dealers. Hardly 15% of the instrument engineers and technologists have been drawn in the instrument manufacturing industry. Formal qualification thus seems to have better market value in service rather than in the instrument industry.

By and large, scientific instrument making is the work of scientists who are available in good numbers in the country. Instrument making is as much an art as science or technology. The success depends on the tradition which an instrument manufacturer builds up. Tradition cannot be planted from outside. One would ponder how the Zeiss and the Leitz companies built their finest instrument traditions : institutional training in instrument technology was not known in those days. Good scientists, engineers and mechanics are located and trained on the job.

With the growing demand, formal education in instrument technology is now available. However, men with the formal qualifications and training are in short supply everywhere.

Building up personnel

Instrument technology is an inter-disciplinary scientific activity. When formally trained personnel are not available, persons qualified in general engineerng or science can be effectively trained for instrument production within the industry. The success lies in selecting scientists, technologists or engineers who have a personal liking and love for instrument designing and making. The industry can freely draw upon physicists, chemists, mathematicians, electrical engineers, mechanical engineers, electronic engineers and so on.

It may be pointed out that in 1960 in the U.S.A., 22,000 engineers and 4,400 scientists were engaged in professional and scientific instruments industries. This excludes electrical equipment (other than machinery) industry, in which more than 91,000 engineers and 10,000 scientists were engaged. Among these 15,000 scientists engaged in scientific instruments and electrical equipment industries, 34% are physicists, 39% chemists, 14% mathematicians, and 13% other scientists including biologists and medical scientists. It is obvious that all these scientists and engineers have not come through the formal education and training in instruments engineering or technology.

Where more sophisticated instruments are concerned the work becomes closer to the individual scientists and engineers who have better comprehension of basic sciences. Today, more and more complex and sophisticated instruments are coming into existence, and they originate from the hands of these who had to evolve them in the first instance for their own needs. The contention that instrument industry cannot progress without formally trained instrument technologists is, therefore, not justified.

Technicians

The same remark goes for instrument technicians and mechanics. A fine mechanic can be a fine mechanic for instruments as for any other fine work. India had and still has excellent workmen, even though many of them are illiterate. Indian craftsmanship is unsurpassed. The new generations are taking to modern machines and they are demonstrating the same sensibility, appreciation and delicate performance. Most of our industries are manned by these mechanics and craftsmen. Our instrument manufacturers are also utilizing them with considerable success. Those who have launched on instrument making in this country have hardly found anything to complain about technicians and mechanics. But those who have not started, always find it difficult to start the industry without a band of ready-made instrument technicians and engineers.

A scientific business

Instrument manufacture is not the job of a financier who is merely interested in making money. He will be impatient. He will not be able to align himself with the sentiments of his scientists and technicians. This is the business of a scientist or a financier who has a fascination for it. Scientific and research bias has to be the primary motivation, although the instrument industry, in the long run, is one of the most profit-accruing business.

Contemporary World Engineering Project
Series—29

Members are invited to contribute to this Series special articles featuring major engineering projects with which they have been associated in any manner. Articles should be preferably accompanied by photographs and illustrative sketches.

MONT BLANC—THE WORLD'S LONGEST ROAD TUNNEL

Introduction

August 14, 1962, was a very important date in the history of the Mont Blanc tunnel. On that day the last remaining wall of rock separating the two-halves of the tunnel was blasted. After three and a half years Italian and French drilling teams were at last able to meet in the middle of Europe's highest mountain. That day ended the most difficult and dangerous part in the construction of the world's longest road tunnel (11.6 km.—7 miles) which has brought Paris 194 miles (312 km.) nearer Milan.

The Mont Blanc operation was once described as involving two separate jobs that might as well have been on opposite sides of the earth rather than on opposite sides of the same mountain. Although there were difficulties which were common to both sides it has never been disputed that the conditions—both as to rock and water—were incomparably worse for the Italians. This meant they had to employ methods and equipment which were flexible enough to meet constantly changing conditions. Compressed air was the power which made it possible to penetrate 7 miles (11.6 km. through Europe's highest mountain.

The Italian half of the tunnel turned out to be three and a one-half miles (5,800 m.) of constantly varying problems and of continuous adaption of working techniques to the changing geological conditions which the Swedish tunnelling method successfully overcome. The only constant factors were the courage and the skill of the drilling crews and the flexibility of their lightweight drilling equipment. Throughout the project, whether they were driving the tunnel full face with a record advance of 807 ft. (246 m.) in one month or drilling a pilot tunnel knee deep in water, the Italians used hand-held rock frills.

The story of rock bursts, roof falls and flood hazards—at one stage over 15,000 gallons (68,000 litres) a minute—ended on August 14, 1962, but the work that was still to be done, if less sensational, was no less important. A long dark stretch of tunnel running for 7 miles (11.6 km.) through a mountain had to be transformed into an international highway.

The road

The contractors who built the Italian half of the tunnel, Societa Italiana per Condotted' Acqua approached the problem with no precedents of similar dimensions to guide them. In the limited area of the tunnel the transportation and placing of the precast concrete blocks that were to form the road surface presented a number of difficulties.

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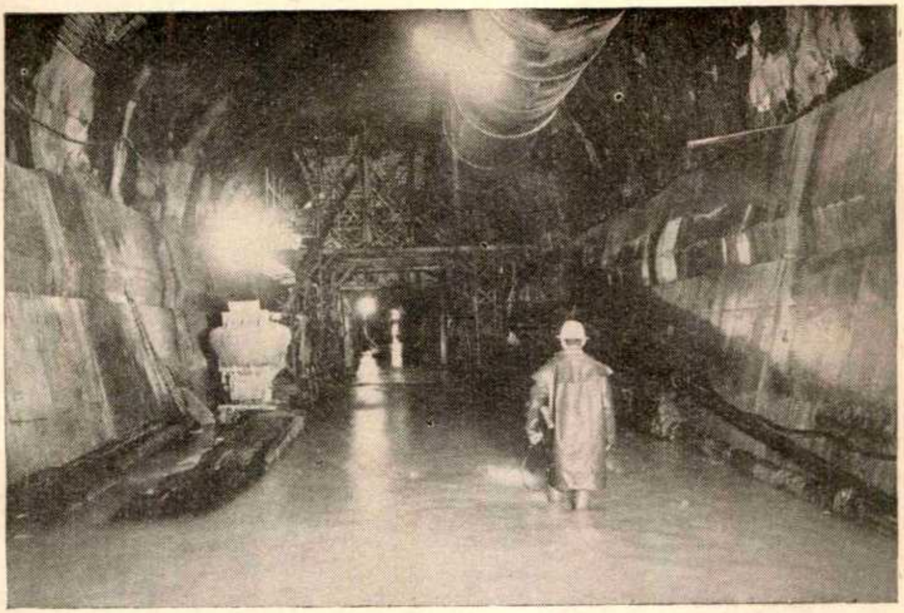
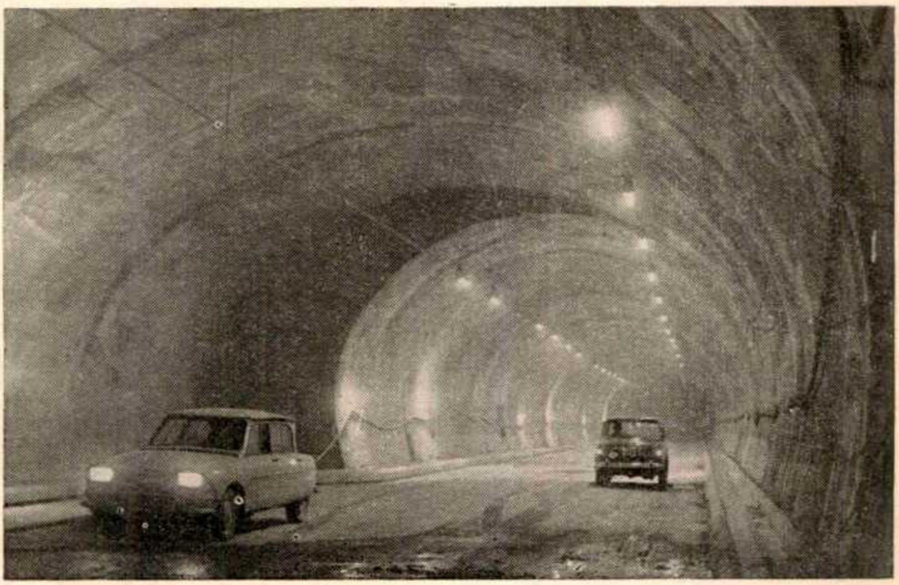


This picture shows the difficulties that had to be overcome before the tunnel could be completed



The Mont Blanc road tunnel—the longest road tunnel in the world

These blocks were precast in a plant specially built by the contractor on the site, a few hundred yards from the tunnel entrance. Extending over 3,000 sq. yd. (2,500 m.^{2}) the plant was fitted with thermally insulated walls and roof to guarantee the constant temperature needed for the curing of the blocks. Steam curing enabled the usual seven or eight-day process to be reduced to a few hours and to be carried out on site.

The large concrete blocks which form the centre of the road surface are 33 ft. (10 m.) long and 13 ft. (4 m.) wide and vary in depth from 10 ft. 11 in. (3.35 m.) to 12 ft. 1 in. (3.70 m.)—with an average weight of 90 tons, the heaviest being 106 tons. These centre blocks were not all made to the same pattern as below and road surface they help to form not only the road but the ventilating ducts underneath which vary in number according to the distance from the tunnel entrance. They were transported to their position inside the tunnel by a truck mounted on 32 wheels. This was a delicate operation as the dimensions of these blocks were such that they could only just enter the tunnel, maximum width 30 ft. (9.15 m.). A swerve of the truck or of the crane could have meant a block hitting the side of the tunnel or falling to the ground. After the large centre blocks were placed in position the road surface was completed with precast side blocks.

The blocks were left to settle for one month and the joints between them were then grouted with cement. The road surface on the Italian side was thus assembled piece by piece. About 150,000 cwt. (80 quintals) of cement and 3,500 tons of steel were used. Some 250 workers were employed in the precasting and placing of the concrete blocks.

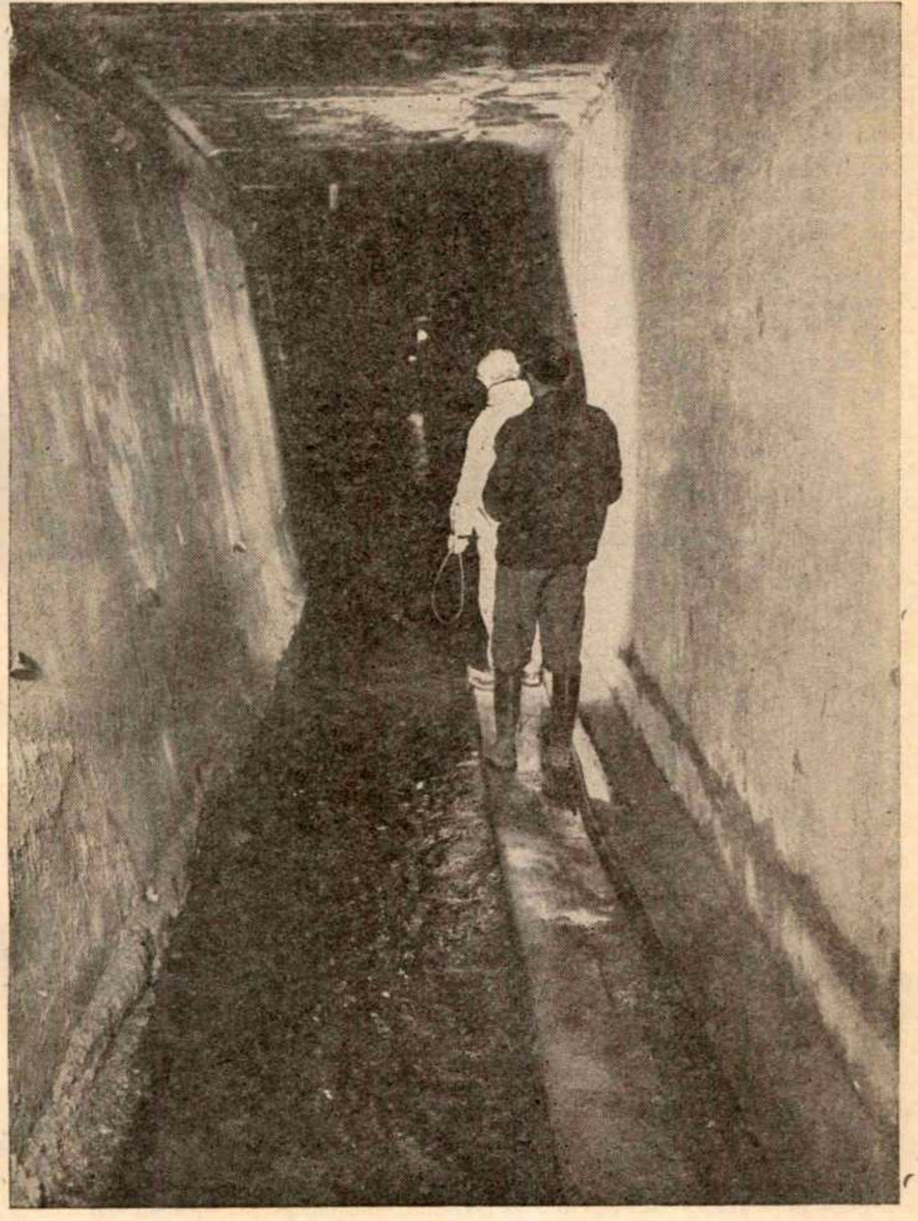
The blocks were laid on sheets of neoprene to allow for easy movement during the compression phase. Every 18 blocks, *i.e.*, every 197 yd. (180 m.) special couplings were inserted in the joints instead of cement. These couplings with hydraulic jacks, exercise a pressure of 120 to 130 atmosphere (1,700 to 1,800 lb. per sq. in.) and ensure that the blocks are always under compression to prevent leakage from the air ducts underneath the road.

Three of these bloks were specially reinforced and anchored in the rock beneath the road to act as abutments for the other precast blocks during the compression phase. Each of these blocks weighs some 1,500 tons. They were anchored in the rock by 59 ft. (18 m.) cables set in cement to a depth of 13 ft. (4 m.) and stretched at almost their maximum tension.

Ventilation

One of the major tasks has been to provide efficient and adequate ventilation. Alpine air has a quality of its own which, of course, does not penetrate very far into a seven-mile tunnel. As it was not feasible to sink ventilation shafts down through the mountain, two extensive ventilation plants—one at each end of the tunnel—had to be built. These installations have to handle the exhaust gases of 600 vehicles an hour while providing fresh air to all parts of the tunnel. Designed by Italian Societa Marelli, each plant is equipped with four centrifugal units for pumping in fresh air, three for drawing out polluted air and one in reserve. Fresh air is circulated under the road inside the hollow concrete blocks and enters through openings at road level while exhaust air is drawn out through holes in the roof, and expelled through a duct under the road. The road is divided into 1,640 yd. (1,500 m.) ventilation sections, each one of which is served by its own air duct.

The ventilation system provides fresh air for 120 vehicles in the tunnel at any one time. A maximum of 600 vehicles an hour will be allowed and the speed limit will vary



One of the air ducts and the drain for carrying seepage water

between 30 and 43 miles per hr. (50-70 km. per hr.) according to the density of traffic. It is estimated that it will take a car on average 12 min. to pass through the tunnel. With these figures, even if all the ventilation units were to break down, including the reserve unit, there would be sufficient time for every vehicle inside the tunnel to reach the open before the air became toxic. These giant mechanical lungs are hidden below ground within a few yards of the entrances at each end of the tunnel.

There is little doubt that the Mont Blanc tunnel will become one of the main arteries in a complex of highways spreading across the Continent of Europe. Already it is being considered as an engineering feat as significant to this century as the completion of the Suez Canal and the Trans-continental railroads of North America were to the last. The words of Bienvenue, the builder of the original Paris Metro, could equally well have been said of the Mont Blanc project "Nature is ever ungrateful to the tunneller. If he has done his job properly, no evidence of the difficulties he had to face must appear in his finished work. He can only ask the traveller to believe him on his work".

Some salient details of the tunnel are given below.

Height of Mont Blanc	16,780 ft. (4,810 m.)
Length of tunnel	70 miles (11,600 m.)
Section of tunnel above road level	495 sq. ft. (46 m.2)
Height of tunnel above road level	20 ft. (6 m.)
Maximum width of tunnel	30 ft. (9.15 m.)
Section on lined tunnel before road was laid	754 sq. ft. (70 m.2)
Average time to travel through tunnel	12 min.
Maximum number of vehicles in the tunnel at one time	600
Volume of rock excavated	1,308,000 c.yd. (1,000,000 m.3)
Date of drilling started	January 8, 1959
Date of completion of drilling	August 14, 1962

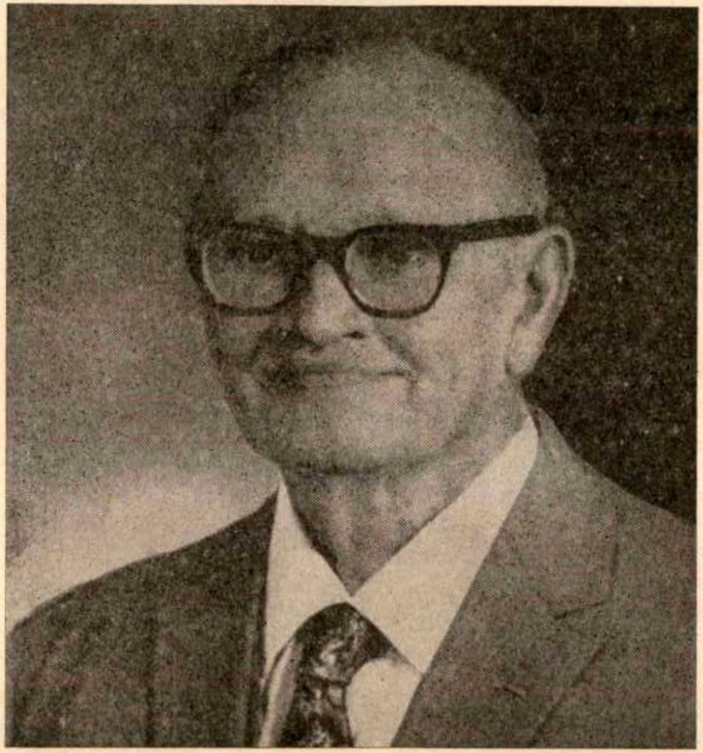
Intensity of illumination at road level 200 lux for first and last 148 yd. (135 m.) and 30 lux inside the tunnel.

The tunnel runs between Courmayeur (in Italy) and Chamonix (in France) and has two 11 ft. 5 in. (3.50 m.) road lanes with a 2 ft. 5 in. (0.75 m.) pavement on each side of the tunnel.

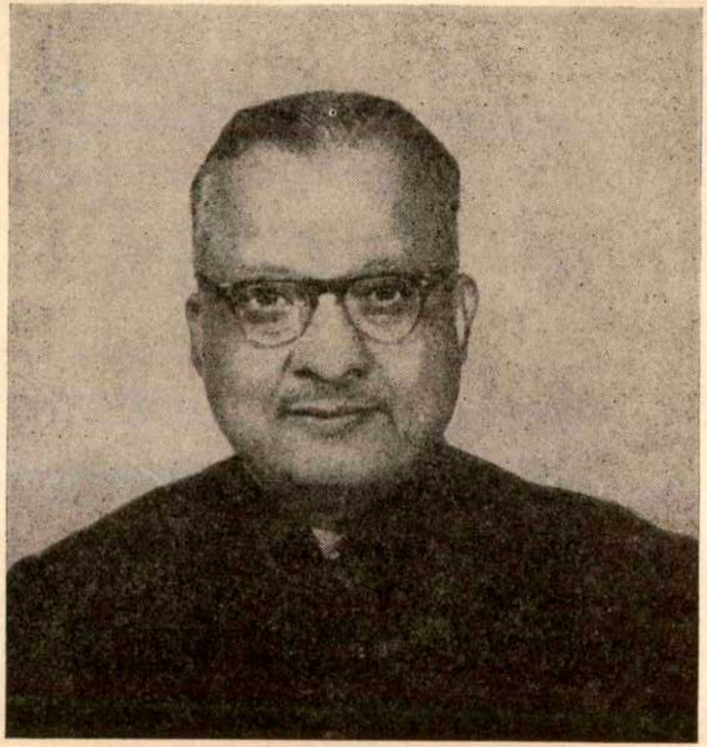
PROCEEDINGS OF THE FORTY-SIXTH ANNUAL GENERAL MEETING, PATNA, JANUARY 31-FEBRUARY 6, 1966

The photographs taken at the various functions during the 46th Annual General Meeting held at Patna are given in these pages.

46TH ANNUAL GENERAL MEETING PATNA, JANUARY-FEBRUARY 1966

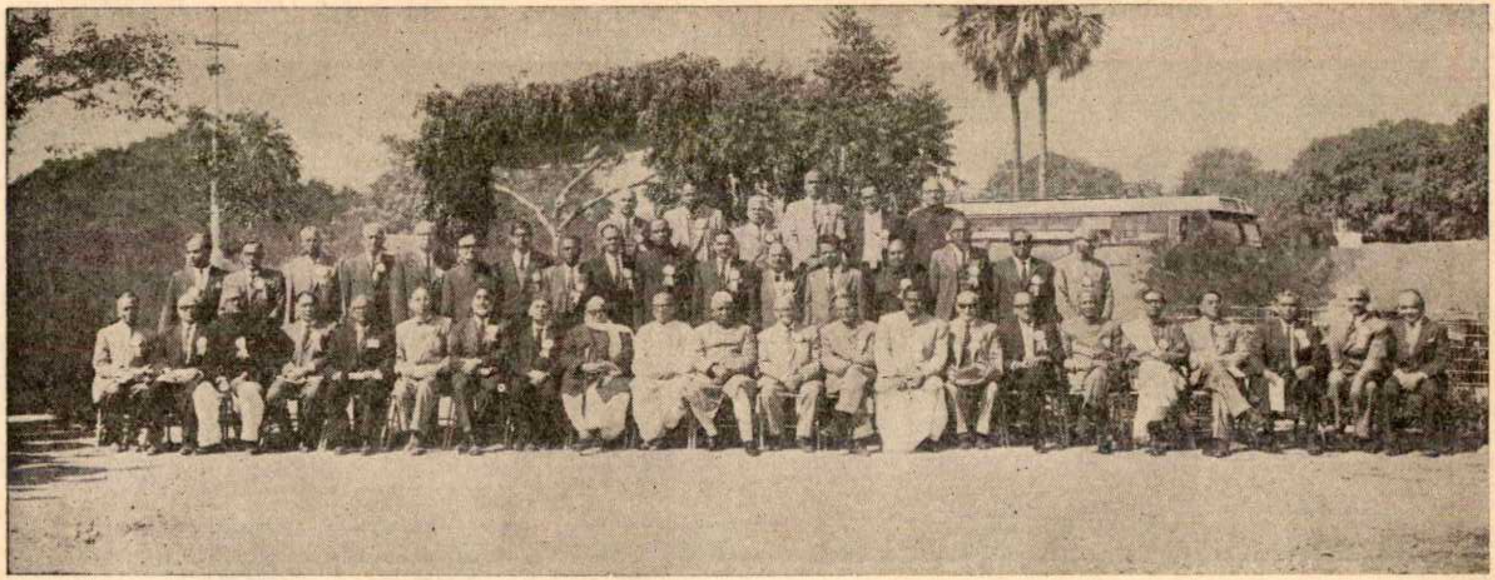


SHRI B. P. KAPADIA
PRESIDENT FOR THE SESSION 1966-67



PROF. N. S. GOVINDA RAO
PRESIDENT FOR THE SESSION 1965-66

46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966



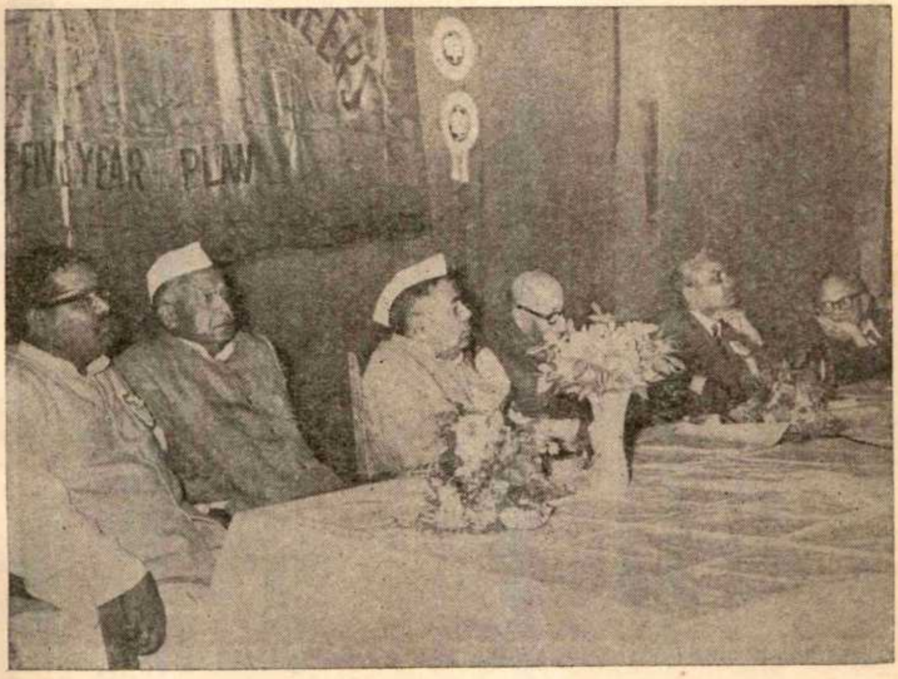
THE COUNCIL 1965-66 AND THE PAST-PRESIDENTS WITH THE CHIEF GUEST AND OTHERS

Sitting : Front row (L. to R.) M. Ganapati, J. G. Bodhe, S. N. Sinha (*Chairman, Bihar Centre*), Maj.-Gen. S. P. Vohra, T. P. Marik, K. F. Antia, Maj.-Gen. Harkirat Singh, Dildar Husain, His Excellency Shri Ananthasayanam Ayyangar (*Governor of Bihar*), Dr. T. Sen, Y. B. Chavan (*Union Minister for Defence, Chief Guest*), B. P. Kapadia (*President*), Dr. K. L. Rao (*Union Minister for Irrigation and Power*), R. L. Singh Yadav (*Minister for Public Works, Bihar*), F. A. Nadirshah, K. K. Nambiar, T. R. Gupta, Prof. H. C. Guha, K. C. Banerjee, S. K. Laha, Brig. M. K. Rao and D. K. Ghosh (*Deputy Secretary*)

***Standing** : Middle row (L. to R.)* N. G. Mahalingam, Dr. G. P. Chatterjee, B. K. Dutta, R. S. Mehta, B. V. Raman, G. S. Desai, S. K. Mukherjee, G. C. Goswami, D. G. Tamaskar, S. Padhi, Lt.-Col. R. S. Attre, Col. R. V. Godbole, K. C. Das, Prof. A. Lakshmanaswamy, I. A. Magdum and M. P. Sitaram

***Standing** : Back row (L. to R.)* Maj.-Gen. R. A. Loomba, Prof. M. V. Deshpande, Prof. C. H. Khadilkar, Y. A. Khare, Dr. A. Bhattacharyya and K. N. Rohatgi

46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966

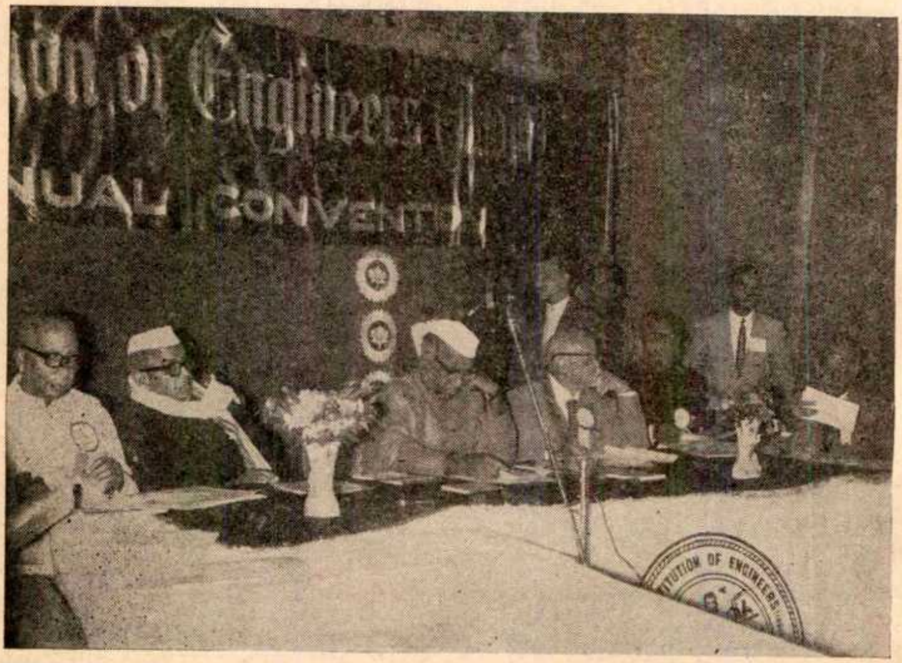


INAUGURATION OF THE SEMINAR ON 'THE ROLE OF THE ENGINEER IN THE FOURTH FIVE YEAR PLAN' AT THE RABINDRA BHABAN

DR. T. SEN DELIVERING THE NINTH SIR MOKSHAGUNDAM VISVESVARAYA LECTURE

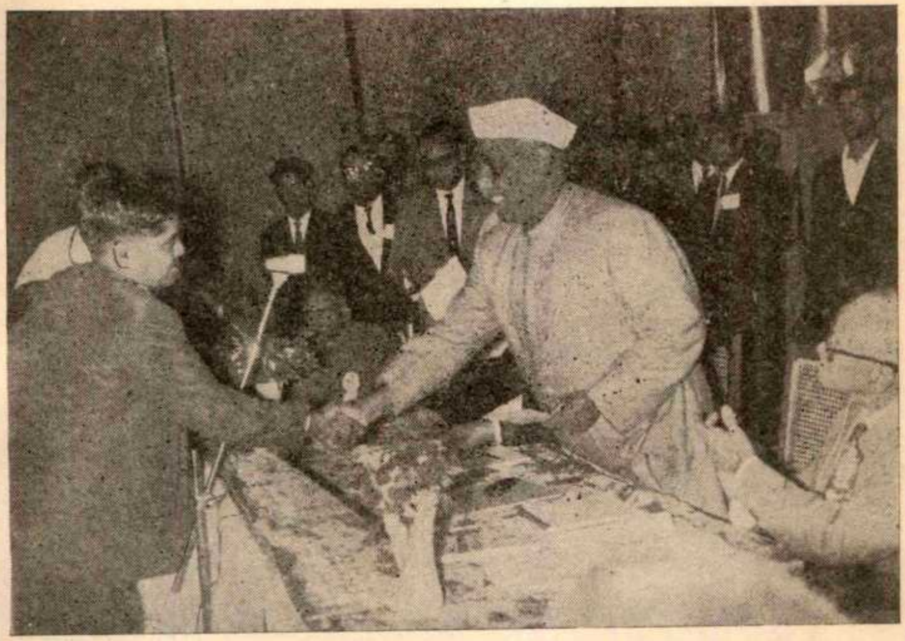
46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966

INAUGURAL SESSION OF THE 46TH ANNUAL GENERAL MEETING AT THE RABINDRA BHABAN

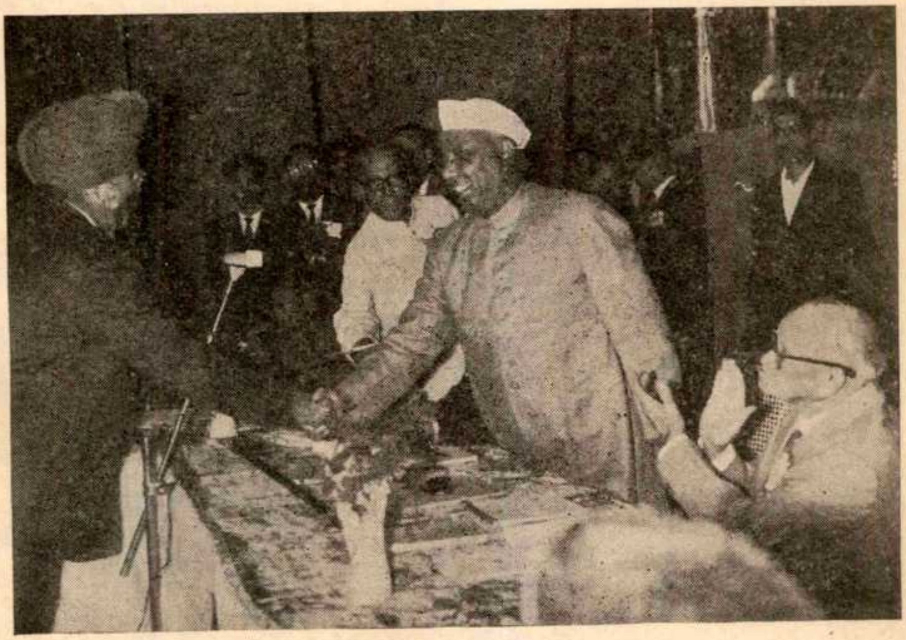


A VIEW OF THE DAIS DURING THE INAUGURAL SESSION

46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966

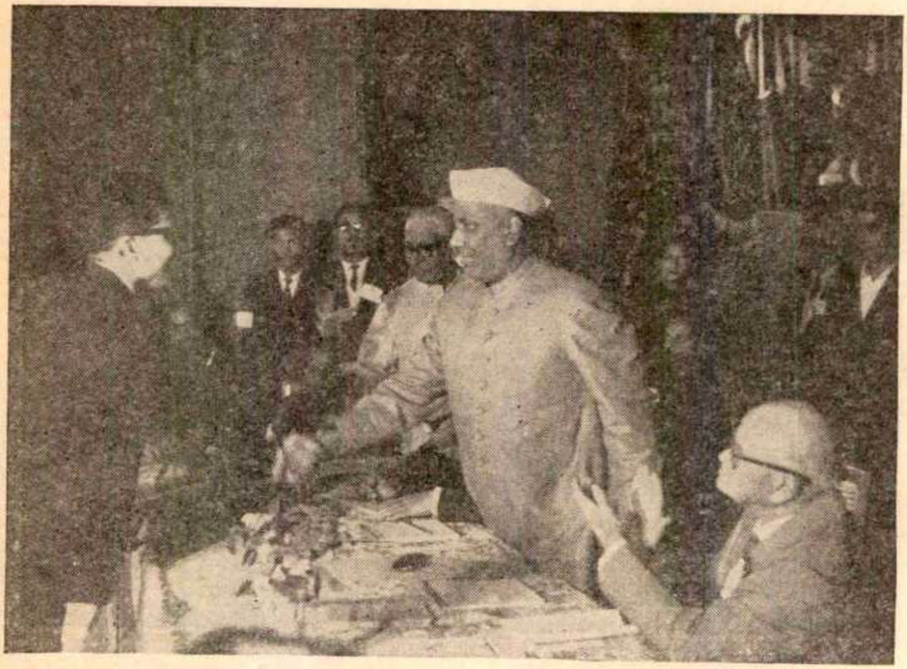


DR. B. S. MURTHY (*A.M.*) RECEIVING THE RAILWAY BOARD'S SECOND PRIZE FROM SHRI CHAVAN



DR. GAJINDER SINGH RECEIVING AN UNION MINISTRY OF IRRIGATION AND POWER GOLD MEDAL AND CASH AWARD FOR THE BEST PAPER ON CIVIL ENGINEERING ASPECTS FROM SHRI CHAVAN

46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966

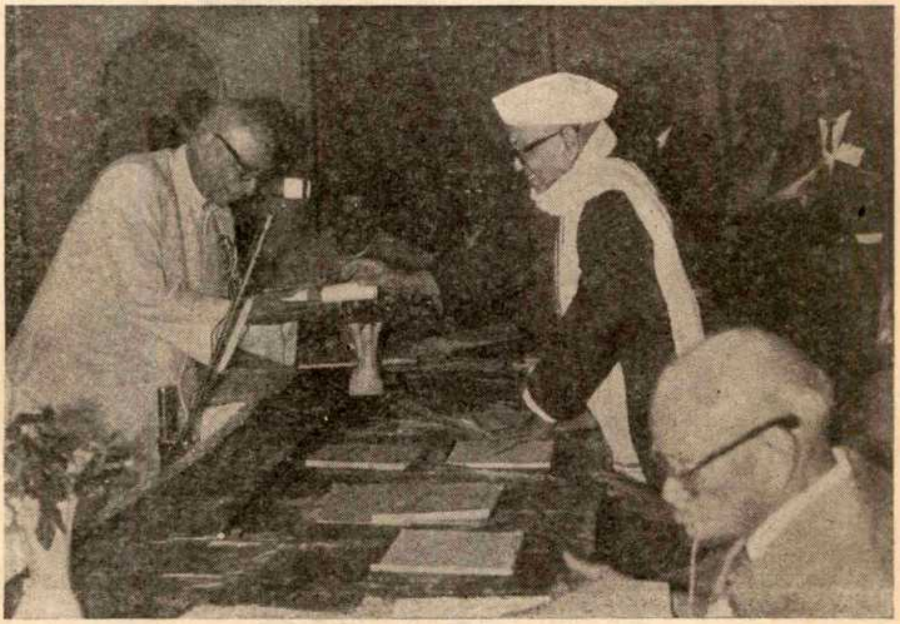


DR. S. C. DASGUPTA (*A.M.*) RECEIVING AN UNION MINISTRY OF IRRIGATION AND POWER GOLD MEDAL AND CASH AWARD FOR THE BEST PAPER ON POWER DEVELOPMENT AND UTILIZATION FROM SHRI CHAVAN

PROF. P. S. KALWACHWALA (*A.M.*) RECEIVING THE JAWAHARLAL NEHRU MEMORIAL GOLD MEDAL

46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966

Shri Dildar Hussain Receiving the Scroll of Honour from His Excellency Shri Ananthasayanam Ayyangar, Governor of Bihar



Dr. T. Sen Receiving the Scroll of Honour from His Excellency Shri Ananthasayanam Ayyangar, Governor of Bihar

46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966

Sir Jehangir J. Ghandy who was Awarded the Honorary Life Membership (*in Absentia*)

Shri B. P. Kapadia, President, Addressing the Gathering

46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966

SHRI Y. B. CHAVAN DELIVERING THE INAUGURAL ADDRESS

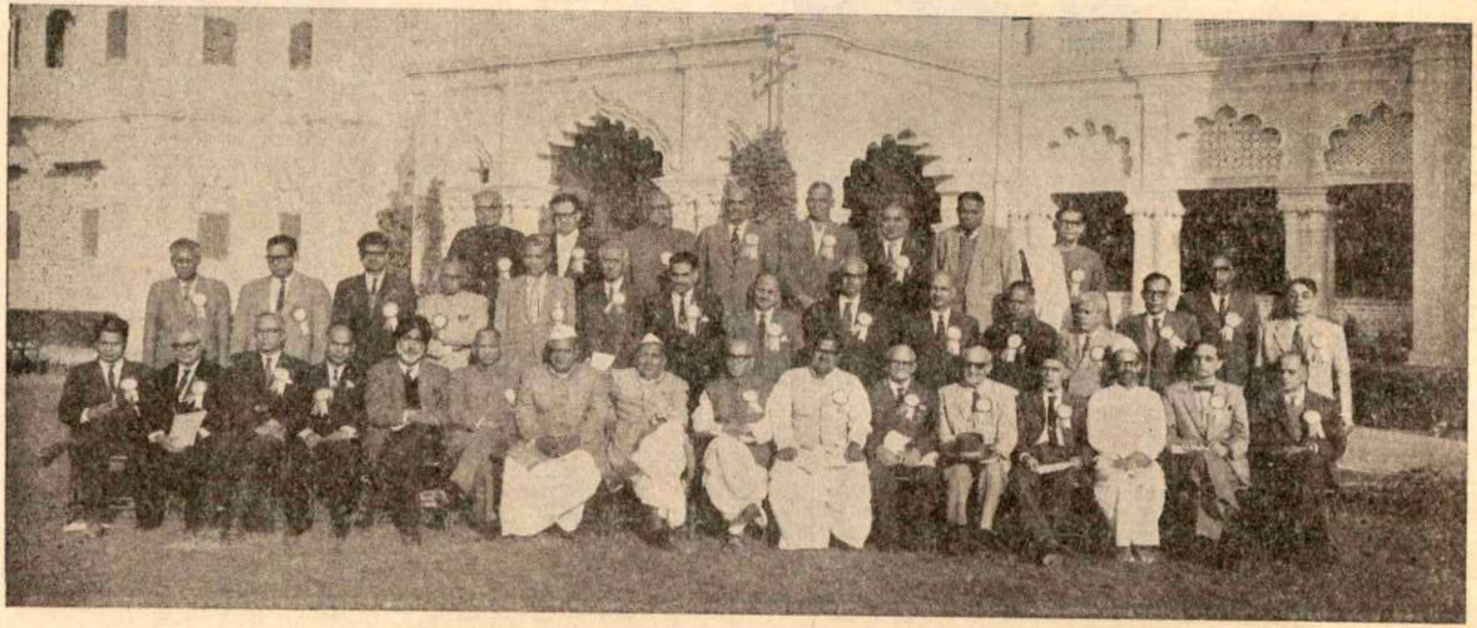
HIS EXCELLENCY SHRI ANANTHASAYANAM AYYANGAR, GOVERNOR OF BIHAR, ADDRESSING THE GATHERING

46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966

A VIEW OF THE DISTINGUISHED AUDIENCE AT THE INAUGURAL SESSION AT RABINDRA BHABAN

DR. T. SEN AND SHRI DILDAR HUSSAIN, HONORARY LIFE MEMBERS, WITH SHRI D. K. GHOSH, DEPUTY SECRETARY

46TH ANNUAL GENERAL MEETING, PATNA, JANUARY-FEBRUARY 1966



COUNCIL MEMBERS AT THE 'AT HOME' GIVEN BY SHRI R. L. SINGH YADAV (*Minister of Public Works, Bihar*)

ADDRESSES OF CHAIRMEN AT THE ANNUAL GENERAL MEETINGS OF THE LOCAL CENTRES

Bengal Centre

Chairman's address by Shri T. P. Marik, B.Sc., B.E., M.I.E., at the 45th Annual General Meeting of the Centre on December 26, 1965

The Chairman welcomed the Chief Guest, other invitees, and thanked the Committee of the Centre for electing him the Chairman for the coming year.

Delivering the Chairman's address, Shri Marik said, 'I shall devote myself on the housing and road communication problems in West Bengal with which I was associated for many years. These problems are required to be solved to tide over the miseries of our people, particularly of the people of lower middle class, slum dwellers, industrial workers and cultivators.

With the ever increasing and rapid growth of population, unceasing influx of millions from Pakistan, shortage of land due to rapid industrialization and greater deployment of limited resources in men and materials for the defence needs, caused by aggression of China and Pakistan, the problems have become more difficult to solve.

Upto 31st March, 1965, the State Government have built about 10,000 houses of 200 sq. ft. of living space and rented them at 50% subsidised rate of Rs. 36 per month whereas the employers with 25% Government subsidy and 50% of the cost as loan from the Government have built nearly 2,500 houses. The State has also introduced a housing scheme in which loan of 80% of the cost upto the ceiling cost of Rs. 3,000 per unit is given to the tea planters. About 400 houses have been built against 796 sanctioned in the Third Plan and 170 built out of L.I.C. loan against 437 sanctioned.

The State Government have prepared two schemes for slum clearance, *viz.*, (i) Provision for alternative accommodation—which comprises of building two roomed houses, costing not more than Rs. 7,600 with 37.5% Central subsidy, the State's matching grant of 25% and balance 37.5% to be met from Government loan ; and (ii) Slum improvement—which involves in acquisition of the owners' right over the land with a view to provide basic and essential facilities. The project seems to be feasible one and the Government may improve all the slums within 10 years.

To mitigate the housing problems of people of low and middle income group, the Government have so far built 1,416 units against the sanction of 2,500 and also sanctioned private construction with loans from Government upto 80%. A Rental Housing Scheme for the Government employees has also been introduced.

As the value of land is soaring up, the States should acquire all waste and unproductive lands to develop them into small townships and sell in small plots at reasonable rates to the common people. Our State has developed some areas at Durgapur and has been developing the Salt Lake area. The land is also acquired in the outskirts of

Asansol, Behala and Patipukur. Such townships should be established in much growing number, especially in big cities, to cope with the present situation. The new small townships will ease the housing problem and relieve over-congestion in the cities.

The roads and other systems of communication are vital and indispensable for the development of country. The roads of a country serve as an index of its development in respect of agriculture, commerce and industry. Although, sound motorable roads are necessary to connect one State with the others and the districts with sub-divisional towns, we must not overlook the needs of more than 6 lakhs of villages which require at least fair all-weather roads for their development. Proper attention has not been paid by the Government in this direction and more than 36% of villages still lie 6 to 8 miles and about 25% lie 4 to 5 miles away from metalled roads. Undoubtedly, attention has to be diverted towards the border roads for defence purposes, nevertheless it is important to spread out the network of village roads to alleviate the miseries of the poor masses.

To manage with the funds available, not only the planning of future Plans should be revised but a vigorous research should be made to alter the present designs and specifications of roads. The upward trend of cost of construction devolves upon us, the engineers, to find out ways and means to tide over the difficulties and bring down the cost appreciably.

Due to the dearth of foreign exchange and increased defence needs, we must strive through ingenuity and innovations to produce indigenous products. The shortage of labour can be overcome by their accelerated training and by adopting methods requiring minimum labour.

To prevent the misuse of foreign exchange, all projects must be prepared more realistically, taking into consideration of the resources in men, materials and plants of this country. It is necessary to make a periodical survey of men, materials and machinnery and to promote the growth of indigenous industries.

It is time to make efforts to stand on our own legs and to avoid dependence on foreign consultants and collaborators.

As regards the role of engineers to solve the ticklish food problem, they are very much in picture in our Institution as builder of dams, barrages, canals and wells, roads and railways, godowns, plants for fertilizers as well as machines, all required for production, storage and transport of food grains. The country should produce more agricultural engineers and the field of their activities should be enlarged. More contribution can be made towards minor irrigation and establishment of more fertilizer plants. The assured supply of water and also of fertilizers within the means of peasants will help to feed the nation without any import.

Attention for agriculture has been given at the highest level in this State and the Government of India has also taken important decisions. The Hon'ble Union Ministers Dr. K. L. Rao and Shri C. Subramaniam have already emphasized the role of engineers in the food-projects.

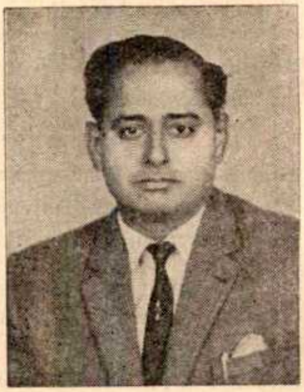
Although, the Institution has stressed from time to time, I would reiterate our just demand for ushering engineers in administration in summit positions as that would not only accelerate the progress of work but much economy could also be effected in every line. The inadvisability of charging the administrative civil servants with the responsibility of execution of all technical projects or schemes has been emphasized only the other day by the U.K. expert, Sir Denis W. Brogan, before the Institute of Public Administration in India.

In conclusion, I would say that we, engineers, must strive hard and harder to attain self-sufficiency in every respect to achieve our goal of economic independence'.

Mysore Centre

Chairman's address by Shri I. M. Magdum, B.E., M.I.E., at the 31st Annual General Meeting of the Centre on December 23, 1965

The Chairman welcomed the Chief Guest—Hon'ble Chief Minister, Minister of Finance, Mysore, and other invitees, and thanked the members of the Committee of the Centre for electing him the Chairman for the year 1965-66.



Delivering his address, Shri Magdum said, 'The Mysore Centre has lived upto the high traditions of the Institution of Engineers (India) by its conduct and performance in many ways. The strength of the membership of the Local Centre has risen to 3,550 including 2,560 Student Members in the year 1964-65. During the year the Centre has organized 45 lectures and film shows. Two Sub-Centres one at Mysore and the other at Dharwar are being formed shortly. The two Student Chapters one at Bangalore and the other at Hubli are functioning actively. The Centre has also arranged the interesting Seminars on subjects such as the 'Challenge of Sharavathi', 'Utilization of Water Resources', 'Electricity Tariffs', 'Prospects of Mineral based Industries', 'Low Cost School Buildings', 'Planning for Development of Human Resources', etc. The Fellowship meetings for exchanging technical information were a new feature for the year. His Execllency Shri V. V. Giri, Governor of Mysore, and Prof. M. S. Thacker were amongst the distinguished guests at these meetings.

We are virtually living under war-clouds. The engineers should therefore take up the challenge and help the country to preserve independence and maintain economic freedom. While the valiant Jawans have taken good care of defence, the rest of us must contribute to economic development of the Nation. The continued dependence on food imports would endanger the independence. As our Prime Minister has put it, "Self-sufficiency in food is no less important than impregnable defence in the preservation of freedom". It is here that our engineers in general and irrigation engineers in particular face the challenge only to be conquered.

One of the chief reasons as I guess, for conferring the honour of chairmanship on an irrigation engineer like me seems to be the emphasis which the members want to lay on the importance of irrigation. Due to Chinese invasion and Pakistani aggression, the hesitation on the part of leading nations to meet the food deficit and failure of rains, we have had to pass through a very severe drought during the current year. The provision of water for cultivation is the main concern of the irrigation engineer. The rainfall in some places is as low as 10 in., the higher being as high as 500 in. The distribution of rainfall is also uneven through out the seasons. Due to these facts, the development of irrigation in India could be traced to the dawn of civilization. In the Vedas, mention is made of wells, canals and dams. The systematic and large scale irrigation started in later days with the construction of Grand Anicut canal on Cauvery, the channels and tanks of Vijayanagar days in south and the Ganges canals in the north. The British Government constructed large irrigation works.

The advent of Independence ushered in an era of spectacular development in the field of irrigation engineering. After Bhakra Dam, we have embarked on projects such as Beas-Sutlej link complex of dams and tunnels. Rajasthan Canal Project, Ramganga Project, Yamuna Project, Nagarjunasagar Project, and Farakka Project. Coming to our own State, the Tungbhadra, Bhadra, Upper Krishna, Ghataprabha and Malaprabha projects in Krishna valley and projects of Cauvery valley are examples of our State's achievement and ambitions in recent times.

The total annual rainfall over entire country is slightly more than 3,000 million acre-feet of water. Out of this only 1,350 Million acre feet is available as surface water after evaporation and percolation. But due to physiographical conditions, only 450 million acre-feet of water can be used for irrigation. Similarly out of 650 million acre-feet of percolated water only 300 million acre-feet is available as ground water which can be tapped annually for irrigation. During pre-independence, 76 million acre-feet of water was utilised annually, irrigating an area of 52 Million acres out of cultivable area of 476 million acres while it is estimated to go upto 160 million acre-feet to irrigate an area of 85 million acres by the end of Third Plan. The up-to-date 15% of surface flow throws up a challenge to the irrigation engineers for its utilization for the benefit of the people.

According to current estimate, Rs. 6,000 crores is required for total utilization of usable surface water to irrigate 175 million acres. The outlay by the end of Third Plan would amount to Rs. 1,700 crores. A comparatively higher outlay would be required for subsequent schemes on account of difficult terrain and geological conditions. The engineers should catch up the latest developments in the technique of building dams and allied hydraulic structures to tackle difficult foundation conditions. The construction of high dams like Serre-Ponco, Mut Mark, and Aswan should be sufficient inspiration to Indian engineers.

While the major and medium irrigation schemes benefit large and extensive areas, give more assured protection in years of scarcity and can serve a multiplicity of purposes ; the minor ones require comparatively less outlay, yield quick results but the protection afforded is liable to be cut short in drought years. Therefore a balanced development of major and medium irrigation schemes along with minor ones is essential. All the irrigation projects should be phased intelligently and indigenously.

I would like to emphasize another aspect with regard to the coordinated development because the most suitable sites may lie in one State while the area receiving benefits may lie in another State. The arrangements for inter-State accord on construction and operation are therefore essential and all the States should cooperate in a joint venture. In this direction, setting up of River Boards as envisaged in the River Boards Act of 1956 would go a long way.

In Mysore State, the total irrigated area has gone up from 5 to 7.5% of cultivable area during the various plan periods. An outlay of about Rs. 750 crores more would raise the percentage of irrigated area in the State by 24% of the gross cultivable area which is the target set by the All India Plan. Though our State resources are slender, I urge upon the authorities for large allocations in future so that we may attain the all-India target in 4 or 5 Plans.

Nearly 60 to 65% of the Plan provisions in the public sector is being expended through the construction industry. A small saving in construction cost by way of improving the efficiency would go a long way to achieve substantial financial saving. To keep down the cost of construction, it is worthwhile to consider for both the governmental and non-governmental organizations to make provision to secure the financial advance in several ways. A secured advance could also be made for materials like rubble, jelly, cement, steel and plant and equipment, etc. I request the Government and particularly our Finance Minister to consider the matter favourably.

In the present day administrative set up, there is too much bureaucratic control on the technical services by the administrative services. The engineers should be encouraged to shoulder the responsibility and give results. Both the United States and the Soviet Union have left the technologist to himself. There are many examples in our own country also, where engineers and scientists have been elevated to places of high techno-administrative responsibility. The Railway Board and the Atomic Energy Commission are examples of Departments which are being managed by the technocracy. But these are only exceptions. Our late Prime Minister said, "The scientists and technicians should be associated more and more with administration and planning". Mr. Appleby, an able administrator reformer, condemned the very existence of an administrator-oriented administration in the context of our country's need for technically oriented administration. Similarly our revered President, Dr. Radhakrishnan, once had said, "as civilization grows, more and more complex and new discoveries in science and technology are put to large scale use. The ideal head of such an organisation should be an executive who is also an engineer, scientist or technician". It is high time to realise the fact by authorities for a rapid technological development of the country.

The Institution of Engineers places itself at the disposal of Government and the people for consultation. Thanks to the State Government and other patrons who have been responsible for the construction of new building of our Centre which is nearing completion. It is proposed to start a third Sub-Centre at Mangalore. It is also proposed to start refresher courses on various subjects. The proposals of training schemes are being pursued with the Government. Necessary action has been taken to establish a Research Centre in Bangalore. The Mysore Centre is perhaps the first to propose documentation and consultancy service facilities on specific problems.

A Managing Committee to constitute various branches of the consultancy is being formed with due representation to various organizations including the Government. The

Committee will be charged with the responsibility of drafting rules of business. The staff is also concentrating on organising proper documentation of the available data so as to have full information as well as establish contact with Governmental organizations and leading engineers. It is appropriate that available talent within the State is made full use by properly organising them into various faculties and pooling their rich knowledge and experience to provide consultancy service to those in need. It is hoped that very soon, the rules of business will be drafted and service made available in an organized manner.

Let us all join and determine as one body and offer our dedicated service so that our country's honour and prestige is held in high esteem in the comity of nation throughout the world'.

Summaries of Papers Published in the Journal, vol. 46, no. 7, pts. CI 4, ME 4, and MM 2, March 1966

CIVIL ENGINEERING DIVISION

Design of Most Economical Trapezoidal Section of Open Channels

Dr. K. C. Asthana

Associate Member

and

G. Koteswara Rao

Non-member

This paper reviews the two equations used for the design of most economical trapezoidal section of open channels and brings out that when the bottom width and depth of a channel have to be limited due to physical considerations, these equations, which consider the side slope as a constant, cannot be used. It also gives an analysis to derive the conditions which should be satisfied when either bottom width or depth of a channel, instead of its side slope has to be kept constant.

Use of Plastics in Building Construction

Major A. S. Johur

Associate Member

Plastics have definite usage in both the non-structural and structural fields of the building industry. The development of plastics is still in its infancy and can really be said to be a decade old and all the uses of plastics, in even this particular field of building construction, cannot possibly be resolved in so short a period. But the fact that already application of this material in non-structural, structural and even the space structure has been found, leads one to believe that there is certainly a vast potential in planning the future uses of this material. This paper deals with the applications of plastics in the various aspects of building construction.

Construction of Dock Gate at Bhavnagar Port

B. A. Kapadia

Member

This paper deals briefly with the content which led to the provision of a gate at the entrance to the harbour of the Bhavnagar Port and describes the various details of the construction of the same.

Limit of Submergence in Critical Flowmeters

S. K. Mazumder

Associate Member

This paper analyzes certain aspects of flow in a critical flowmeter and determines the 'modular limit' or 'limit of submergence' for the meter for various constriction ratios and exit conditions. The limit of submergence is proved to be governed by the head losses at the entry and exit and due to friction. It also attempts to correlate these losses with the submergence limit and derives a mathematical expression for the same. A set of curves illustrating the point of submergence for various constriction ratios, entry and exit conditions are proposed and the same verified by experiments. A new type of transition, used for the entry and the exit, was found to be efficient.

Rapid Analysis of Thermal Stress in Intake Tower of a Hydro-Electric Project

B. Pant

Associate Member

and

P. T. Badhe

Non-member

The R.C.C. intake towers in a hydro-electric project support the trash racks and operate the gates at the intake end of the headrace tunnel or conduit. These structures remain partly under water and partly exposed to atmosphere; and hence, considerable thermal stress develops in them at certain periods of the year, particularly in the tropical regions. An estimate of the magnitude of thermal stress, which is necessary for design purposes, can be obtained by the analysis of a space frame involving the solution of a large number of simultaneous equations. This procedure is tedious and time consuming. This paper describes a rapid method of calculation of the thermal stress based on the theory of beams on elastic foundations and illustrates the same by calculating the thermal stress in the 176 ft. high intake tower of Koyna hydro-electric project. The results are verified by model tests and the general applicability and limitations of the method discussed.

Division and Combination of Flow in Open Channels

K. Sridharan

Non-member

and

N. S. Lakshmana Rao

Non-member

The problem of open channel junctions has been investigated by various research workers all over the world. This paper, besides giving a critical review of the existing knowledge on the subject, presents a fresh analysis of the experiments done at the Indian Institute of Science, Bangalore. The problem of division of flow in open channels has been solved based on the concept of constant specific energy and that of a side weir. A solution for supercritical flow, based on the concept of constant velocity along the inlet to the branch has also been given. The limitations of the various assumptions involved in the above theoretical analyses are indicated. The effect of angle of offtake on the discharge distribution is discussed. Based on the experiments conducted at the Institute, simple equations for the ratio of discharge distribution for right-angle offtakes have been obtained, for the conditions when the flow in the main channel is subcritical and that in the branch supercritical. These equations will be useful for preliminary designs purposes. The problem of combination of flow could be solved based on backwater computations or momentum considerations.

Top Zones in an Overflow Gravity Dam

Dr. K. V. Swaminathan

Associate Member

This paper briefly examines the influence of the factors affecting the dimensions of top zones in an overflow gravity dam having a standard crest with vertical upstream face and presents a chart from which the depths of top zones in a gravity dam may be easily obtained. The conditions under which it is not possible to locate the planes separating the top zones in such a dam are then discussed and the possible relative positioning of the planes locating the end of the top zones on the basis of the 'resultant at the middle-third', and safety against sliding with only frictional resistance are critically analyzed. A very useful chart is then developed from which one can predict whether a given set of design parameters would alter the usual positions of the planes locating the top zones.

Vibrations of a Jet Flow Gate Caused by High Velocity Flow

Dr. H. L. Uppal

Member

and

Tarlok Singh

Non-member

This paper deals with the vibration of the high head gates which have caused failure of several hydraulic structures. On the hoist chamber of Bhakra Dam also, it is the vibration of the emergency gate that ultimately led to the failure. The committee set up to find out the causes of the damage of the hoist chamber made recommendations that vibration studies should be specially made on high head gates on model of the jet flow gates, which was carried out. It has been possible to study the horizontal vibrations on the model and the other type of vibrations are found to be proportional to these vibrations. The finding of great practical importance is that the maximum vibration occurs when the gate is opened to 60% or between 55-65% of the full gate opening. It is essential that this extent of gate opening be avoided when operating the gates on the prototype.

Ultimate Strength of Brick Piers Made From Hand-Moulded Bricks

P. C. Varghese
Associate Member
and
Asok Kumar
Non-member

Tests made in the U.K. and the U.S.A. on brick piers indicate that the strength of brick masonry piers depends on many factors, *e.g.*, strength of individual bricks, strength of mortar used and workmanship. These tests were made on bricks of fairly high strength. The usual hand-moulded kiln burnt bricks, available in India, are of much lower strength. The specifications do not mention any minimum strength for these bricks. This paper reports the results of ultimate strength tests on piers built from such bricks. The object of these tests is to verify the safe strength values recommended for these bricks in the Indian Standard Specifications.

ROADS AND ROAD TRANSPORTATION GROUP

Scheme for Improvement of Traffic Circulation in West Approach of Howrah Bridge

S. N. Gupta
Member
and
S. K. Roy
Non-member

The performance of a bridge in discharging the traffic often depends to a large extent on the ability of the approaches. The delay and congestion on Howrah Bridge is largely attributable to the inadequate layout of the two approaches. This paper discusses the complexity of the problem describes the scheme for improvement of traffic regulation in the west approaches of Howrah Bridge explaining the benefits that would be achieved by the scheme.

SHELL STRUCTURES GROUP

Computer Analysis of Folded Plates by the Method of Transfer Matrices

M. Ramaiah
Associate Member

This paper presents a modification of Holand's method for the analysis of folded plates and extends it to analyze the northlight folded plate structures. It also presents a programme for analyzing a folded plate structure on an IBM 1620 digital computer using the method.

MECHANICAL ENGINEERING DIVISION

Explosive Fabrication of Metals

T. S. Chennabasavan

Non-member

and

R. N. Singhal

Non-member

Explosive fabrication is one among the many techniques for fabricating metal parts. This paper deals briefly with the various aspects of the process and brings out its comparative merits in the field of metal fabrication.

Design of a Bicable Aerial Ropeway

S. N. Ghosh

Non-member

and

S. C. Jana

Associate Member

In spite of the great use of the aerial ropeway as a means of transport since its inception in 1644, very little information is available on the subject in our country. This paper attempts to discuss some salient features of this type of transport and its superiority over the conventional ones in certain specific situations. It also stresses some basic design consideration to make the principal ropeway calculations for the facility of the practising engineers.

Design, Construction and Calibration of a Two-component Heavy Duty Lathe Dynamometer

G. R. Ponkshe

Non-member

This paper deals with the development of a two-component heavy duty lathe dynamometer and describes the set-up, principles of working, calibration methods, etc.

Velocity Distribution in Heated Commercial Steel Pipes

P. K. Sen

Associate Member

and

Dr. B. N. Chanda

Associate Member

The paper presents the measurement of the velocity distribution in heated and un-heated commercial steel pipes when air flows through them. A portion of a pipe, 3½ ft. long, was electrically heated from the outside at the discharge end. The temperature was raised to 125°C. above the room temperature. The experimental data indicates that the un-heated and heated velocity profile can be expressed by the same universal logarithmic law for the fully turbulent position of the region provided the necessary corrections for the variation of density and viscosity with temperature are incorporated.

INDUSTRIAL ENGINEERING GROUP

Mathematical Programming in Production Control—2

T. L. Subramanian
Non-member
and
C. A. Gilpin
Non-member

Succeeding to the development of algorithm and basic conventional procedure of the simplex method of mathematical programming methods, this paper which is in succession of the earlier paper (*Journal*, vol. 44, no. 7, pt. ME 4, March 1964) presents special techniques that are adopted under deviated conditions to widen the scope of the simplex procedure.

MINING AND METALLURGY DIVISION

Coal Mining Researches in Western Europe and their Applications in India

R. D. Singh
Associate Member

This paper reviews briefly the current researches in coal mining, carried out in the west European countries and indicates the possibilities of utilizing their findings to improve the conditions in Indian coal mines. The problems of coal mining are dealt with in three broad categories : mine environment, rock mechanics and strata control and materials equipment.

INSTITUTION NEWS

The President's Itinerary

Right after the conclusion of the colourful Annual Convention at Patna, Shri B. P. Kapadia, President for 1966-67, initiated meetings with the members of the Bihar Centre Committee as well as the Student members of the State and had lively communion of thoughts regarding the Institution's activities.

Back from Patna, the President inspected the works of Headquarters office in Calcutta and gave a reception to its staff on February 7, 1966, at 3.30 p.m. in Sir R. N. Mookerjee Hall in the Bengal Centre. The next day, the meeting of the Headquarters Building Committee was held at the Bengal Centre hall from 4 p.m. Thereafter, Shri Kapadia addressed a meeting of the Student members of Bengal in the same hall.

The President left for Madras on February 9, 1966· and on the same evening, he adressed a gathering of the Student members at the Madras Centre. On February 10, 1966, a meeting with the members of the Madras Centre Committee was arranged. Thereafter, the President visited the Andhra Pradesh Centre at Hyderabad where he met the Corporate members as well as the Student members in a well-attended meeting. He returned to Calcutta on February 15, 1966.

On February 18, 1966, the President held a closed-door meeting with the Bengal Centre Committee members. The Sunday, February 20, was devoted by him to the office works at the Headquarters.

Shri Kapadia left for Bombay on February 21, 1966.

A Tribute to the Past-Secretary

At the Closing Session of the 46th Annual Convention of the *Institution*, held at Patna, on February 3, 1966, Shri B. P. Kapadia, President (1966-67), paid a significant tribute to our Past-Secretary, Shri B. Seshadri, and said :

'I must add a word of appreciation for our Past-Secretary, Shri B. Seshadri, who has left us as well as the country, and record that his sincerity and devotion to the service of the *Institution* is well remembered on this occasion by all the members present here.'

Shri B. Seshadri, B.Sc., A.I.I.Sc., D.I.C., M.Sc. (Eng.), M.I.E., joined the services of the *Institution* as the Assistant Secretary (Technical) on April 24, 1950. He was promoted to the rank of Additional Secretary on April 9, 1955. Shri Seshadri became the Officiating Secretary on July 18, 1957, and thereafter, took office as the Secretary of the Institution on November 17, 1957, in which capacity he served the *Institution* till December 31, 1965.

Shri Dildar Husain, Past-President and Honorary Life Member, has kindly undertaken to unfold the colourful career of Shri Seshadri in a subsequent issue of the *Bulletin*.

Shri Lal Bahadur Shastri

The Council and the General Body of Corporate Members of this Institution passed the following resolution at a meeting held at Patna on 30th January, 1966, on the passing away of our beloved Prime Minister, Shri Lal Bahadur Shastri :

'The Council and the General Body of Corporate Members of the Institution of Engineers (India) record with deep regret the sudden passing away of the beloved Prime Minister, Shri Lal Bahadur Shastri' and send their most sincere sympathies to his wife and members of his family.'

Further resolved that a copy of this resolution be also forwarded to the President of India.

This resolution has been conveyed to Shrimati Lal Bahadur Shastri and to the President of India by the Deputy Secretary.

Dr. H. J. Bhabha

The Council and the General Body of Corporate Members of this Institution passed the following resolution at a meeting held at Patna on 30th January, 1966, on the passing away of Dr. H. J. Bhabha :

'The Council and the General Body of Corporate Members of the Institution of Engineers (India) record with deep regret the sudden passing away of Dr. H. J. Bhabha, who was an Honorary Life Member of the Institution and a scientist of international fame, and send their most sincere sympathies to his mother and other members of his family.'

In this connection, the following message of condolence was also received from the German National Committee of the World Power Conference :

'The German National Committee of the World Power Conference learnt with deep regret that Professor Bhabha deceased by the terrible air accident near Geneva. The high esteem and the amity as well as the recognition of his merits will keep the name of Professor Bhabha as one of the world's greatest scientists. We express our deep sympathy and assure you of our feeling affection.'

The resolution and the message have been conveyed to the mother of the late Dr. Bhabha by the Deputy Secretary.

FORTHCOMING EVENTS

Eleventh Course on 'Water Resources Development', University of Roorkee

The eleventh course on water resources development will be held at the Water Resources Development Training Centre at the University of Roorkee from July 1, 1966. This course, financed by the Government of India, will be of one year duration and is open to candidates sponsored through the State Governments, industries and institutions and hold recognised degrees in engineering or equivalent qualification acceptable to the University and a minimum three years practical experience. Last date of receipt applications is May 3, 1966.

Further details can be obtained from the Professor and Head, Water Resources Development Training Centre, University of Roorkee.

Fourth Congress of the European Federation of Chemical Engineering, London, June 15-24, 1966

The Fourth Congress of the European Federation of Chemical Engineering will be held in London from January 15 to 24, 1966. The purpose of the Fourth Congress is to focus attention on, and improve understanding of the economic factors relating to process plant and its theme is 'Interaction of Technology and Economics in Process Plant'.

The technical programme will comprise six symposia on the following subjects :

(i) Process development and evaluation
(ii) Cost reduction in the design phase
(iii) Cost control of projects
(iv) Cost *vs.* performance in equipment used in unit operations
(v) Control and improvement of plants in operation
(vi) Developments in the movement and shortage of raw materials and products.

Further details can be obtained from the Congress Secretary, The Institution of Chemical Engineers, 16 Belgrave Square, London, S.W. 1.

Symposium on 'Permeability and Capillarity', Atlantic City, June 1966

A symposium on permeability and capillarity for soils and rock will be held in association with the Annual Meeting of the American Society for Testing and Materials during the last week of June 1966, in Atlantic City, New Jersey, U.S.A.

The symposium will describe permeability and capillarity testing techniques—as used in engineering, agriculture, geology, and hydrology—and their application to engineering problems associated with soil and rock materials. The interdisciplinary programme is divided into two sessions : the first emphasizing laboratory testing techniques, and the second emphasizing field techniques and applications.

Further particulars can be obtained from A.I. Johnson, Chairman, Symposium on Permeability and Capillarity, Hydrological Laboratory, U.S. Geological Survey, Federal Centre, Denver, Colorado, U.S.A.

Third International Conference on Water Pollution Research, Munich, September 5-9, 1966

The Third International Conference on Water Pollution Research will be held at the Conference Centre at the Messegelande Theresienhohe, Munich, Germany, from September 5 to 9, 1966. This Conference has been organized by the International Association on Water Pollution Research which was established on June 26, 1965, in Harrogate, England, by the representatives of 17 nations.

The objectives of the conference are as follows : (i) to provide a forum where reports on outstanding research in water pollution from all parts of the world may be presented, and to provide a medium for the publication of such reports ; (ii) to provide an opportunity for scientists and engineers engaged in water pollution research to meet and discuss matters of common interest ; (iii) to stimulate cooperation among nations in the conduct of research by identifying significant research needs of common interest ; (iv) to encourage newly developing nations to participate in conduct of research on water pollution problems; and (v) to promote international goodwill by providing scientists from many nations an opportunity to pool their research experience and knowledge in the solution of water pollution problems.

The programme will consist of opening and closing general sessions and three concurrent research sessions. The research sessions will consist of three sections covering fresh-water pollution, waste treatment, and marine disposal; each of these sections will consist of 16 research papers with prepared discussions.

Further details can be obtained from the Water Pollution Control Federation, 3900 Wisconsin Avenue, Washington, D.C. 20016, U.S.A.

International Conference on Space Structures, London, September 21-23, 1966

An international conference on space structures will be held at Battersea College of Technology, London, from September 21-23, 1966.

Space frames and space structures are gaining rapid acceptance and many important developments have taken place in the past few years. The purpose of the conference will be to bring together those concerned with research, design and erection of braced domes, barrel vaults, single and double layer grids, stressed skin systems and other types of three-dimensional structure. This will allow a comprehensive review to be made of the latest methods in design and construction.

The subjects for conference papers will be concerned with the review of methods of analysis and construction in steel, aluminium, timber and plastics. Except for a reference to the structures with reinforced concrete components, the scope of the conference will not include structures of reinforced or prestressed concrete, because the development of these types of structures has been covered by recent conferences.

Separate session will deal with new developments in assessment of stress distribution in space structures, influence of the electronic computer on analysis, design and experimental analysis, construction in steel, tubular steel, aluminium, plastics, timber, reinforced concrete skeletal components and other materials including those used in inflatable forms of construction. Special sessions will be held for papers dealing with the recent practical applications, the important need for collaboration between architects, consulting engineers and contractors, and also architectural concepts of future use.

Papers are now invited from all countries. They should, preferably, not exceed 6,000 words in length and must be original contributions in English, French or German. The papers should reach the Organising Committee not later than May 3, 1966.

Further particulars can be obtained from The Secretary, Organising Committee of the International Conference on Space Structures, c/o Space Structures Research Centre, Department of Civil Engineering, Battersea College of Technology, London, S.W.11, England.

Third Regional Conference for Asia on Soil Mechanics and Foundation Engineering, Haifa, September 25-29, 1967

The Israel National Committee for the International Society announces that the 3rd Asian Regional Conference on Soil Mechanics and Foundation Engineering will take place in Haifa, Israel, from September 25, to 27, 1967. It has been desired to stress certain subjects considered to be of particular interest to countries in the Asian region, namely :

1. Properties and engineering problems associated with : (i) Aeolian soils, (ii) Lateritic soils, and (iii) Expansive clays.
2. Seepage and infiltration problems
3. Foundations of sea and waterfront structures

Further details can be obtained from the Secretary, Indian National Society of Soil Mechanics and Foundation Engineering, Curzon Road, New Delhi 1.

BOOK ACKNOWLEDGMENTS

1. **Strength of Materials.** D. R. Malhotra and H. C. Gupta. *Tech India Publications*, New Delhi, Rs. 12.50. 479 pages.

In this second revised edition, the chapters on 'Shear Stress in Beams' and 'Springs' have been revised and expanded. Serial mathemetical relationships in M.K.S. units have been added and a few are maintained in F.P.S. units. All the diagrams in the book have been neatly redrawn.

2. **A Text Book of Electrical Technology.** R. C. Handa. *Tech India Publications*, New Delhi, Rs. 22.50. 1213 pages.

The rationalized M.K.S.A. system of units is used in this book. Several chapters such as Magnetism, Electromagnetism, Magnetic Circuits, Electrostatics, and Capacitance have been dealt with lucidly. The subject matter on Operational Algebra, Industrial Electronics, Rectifiers, Economic Costs and Tariffs' have been expanded and rewritten. Chapters on Transmission and Distribution of Electricity and Economic Costs and Tariffs have been revised and a new chapter on Power Factor has been included. Questions from the examination papers of Indian and foreign universities and professional examinations have also been included in the book.

3. **A Text book of Engineering Drawing.** K. L. Narang. *Tech India Publications*, New Delhi, Rs. 15.00. 361 pages.

This book has been written mainly in three parts, *viz.*, geometrical, mechanical, and civil, according to the requirements of the syllabi of various institutions. Most of the diagrams have been drawn by the third angle method of projection recommended by the Indian Standards Institution.

4. **A Text Book of Electrical Engineering Drawing.** K. L. Narang. *Tech India Publications*, New Delhi, Rs. 20.00. 330 pages.

This book covers the syllabus relating to the subject of electrical engineering drawing of the Associate Membership Examination of the Institution and various other degree and diploma examinations of Indian universities. The subject is arranged thus: geometrical, mechanical, electrical, and sketches and connection diagrams of various machine parts. The treatment of the subject is in simple language and has been dealt systematically on practical lines.

5. **Engineering Mathematics.** Vishwa Nath. *Tech India Publications*, New Delhi, Rs. 20.00. 914 pages.

In the fourth revised edition of the book, the chapters on Plane Co-ordinate Geometry, Analytical Solid Geometry, Differential Calculus, Integral Calculus, Differential Equations and Simple Vector Analysis and Graphics have been revised. Solved examples and hints have been added. Topics on reciprocal cones, approximate calculations, etc., have also been included.

6. **Classified Examples in Applied Mechanics.** S. N. Saluja. *Tech India Publications*, New Delhi, Rs. 13.50. 668 pages.

The second revised edition of the book is meant for the students appearing in the Associate Membership Examinations of the Institution and the diploma examinations of Indian universities and polytechnics. In the book are included about 300 solved and graded examples. The questions include those from the examination papers of the Associate Membership examination in Section A up to November 1964. The new chapters included in the book are on virtual work and on circular notion of rigid bodies.

7. **Fundamentals of Electrical Engineering.** R. C. Handa. *Tech India Publications*, New Delhi, Rs. 15.00. 550 pages.

The subject matter is, in fact, a combination of alternating and direct currents, of which the fundamental principles have been stressed and a solid foundation of the basic theory provided throughout the book. Each chapter contains a large number of worked examples drawn from the examination papers of various Indian universities and professional institutions. The chapters on 'Chemical Effects of Currents and Storage Batteries', 'Generators and Motors', including 'Stray Losses' and 'Heating Losses' as well as 'Ratings' have been brought up-to-date and analyzed in detail.

NAMES OF SUCCESSFUL CANDIDATES IN THE STUDENTSHIP AND ASSOCIATE MEMBERSHIP EXAMINATIONS HELD IN MAY 1965

The following candidates have been declared to have passed the Studentship and Associate Membership Examinations held in May 1965.

STUDENTSHIP EXAMINATION

Roll No.	Name of candidate
St. 25	K. S. Gopal
St. 28	Siddanagoud Patila
St. 39	K. S. Narasingarao
St. 40	T. S. Chandrasekhara
St. 43	Felix Fernandez
St. 50	K. L. S. Rama
St. 52	T. V. Raghunathan
St. 53	G. C. Sekhar
St. 55	Santhanam Ramanathan
St. 70	O. V. Padmanabhan Nambiar
St. 81	B. Laxmikumar Holla
St. 86	N. S. Aiyappa
St. 105	V. Sambanda Murthy
St. 112	S. Janakiraman
St. 114	Shankaranarayana
St. 115	M. R. Premachandran
St. 116	P. Varadharajan
St. 137	S. Srinivasan
St. 141	S. Santhana Gopalan
St. 149	A. Yarrama Reddy
St. 154	R. K. Dubey
St. 156	T. N. Moitra
St. 166	G. C. Gupta
St. 172	S. C. Kulshreshtha
St. 178	P. L. Bhat
St. 188	H. J. Bapat
St. 200	E. J. Lobo Prabhu
St. 206	S. R. Pandit
St. 207	L. G. Fernandes
St. 225	V. D. Chaudhari
St. 226	P. V. Rele
St. 234	M. L. D'Souza
St. 238	V. V. Sane
St. 248	K. V. Balakrishnan
St. 257	R. C. Ghosal
St. 271	V. Subramanian
St. 291	A. S. P. Azad
St. 292	Mohinder Singh
St. 297	H. R. Kalsy
St. 298	R. P Jindal
St. 300	S. K. Jain
St. 315	A. S. Bimbraw
St. 328	A. K. Verma
St. 336	V. P. Gupta
St. 341	A. C. Gulati
St. 345	S. C. Jandwani
St. 347	J. N. Kohli
St. 367	R. L. Airan
St. 373	G. R. Khurana
St. 376	Padam Singh
St. 380	Mulk Raj
St. 383	B. P. Robella
St. 395	S. G. Konuri
St. 398	T. Venkateswarlu
St. 399	T. V. S. Rao
St. 402	V. V. N. Murthy
St. 405	P. V. R. K. Rao
St. 406	K. S. Nijjar
St. 410	Muttam Subbaiah
St. 421	Vatturi Satyanarayana
St. 423	Dommeti Sainath
St. 433	V. R. M. Rao
St. 441	S. S. Krishna
St. 442	M. S. Rao
St. 445	N. K. Dutta
St. 450	M. K. R. Reddy
St. 456	Mahamood Syed
St. 459	D. V. Rane
St. 466	Sanandam Pyata
St. 479	P. K. Datta
St. 484	S. N. Saxena
St. 488	S. Uddin Khan
St. 500	K. S. Roy
St. 509	H. S. Bombrah
St. 513	P. K. Sawhney
St. 514	P. N. Sharma
St. 519	R. K. Behl
St. 529	D. Vincent Jayapaul
St. 554	K. K. Das Gupta
St. 587	N. Panchanatham

STUDENTSHIP EXAMINATION—*contd.*

Roll No.	Name of candidate	Roll No.	Name of candidate
St. 588	S. Neelakantan	St. 745	D. V. Narale
St. 592	P. Sundararaman	St. 750	B. M. Suryavanshi
St. 597	M. Karuppannan	St. 751	M. B. Natu
St. 598	A. V. S. Krishnan	St. 759	B. B. Wani
St. 605	R. Chandrasekaran	St. 771	G. B. Sharma
St. 606	C. S. Bhaskaran	St. 774	Harbhajan Singh
St. 617	B. Gnana Sundaram	St. 777	Sant Lall Khorana
St. 636	S. Mallikarjunan	St. 782	R. L. Arora
St. 644	P. Venkata Rami Reddi	St. 783	R. N. Kar
St. 649	A. I. Bhatt	St. 786	O. P. Sardana
St. 677	B. L. Srinivasa Rao	St. 792	O. P. Batra
St. 678	P. C. Varghese	St. 795	M. R. Sharma
St. 685	R. S. Shirwalkar	St. 796	K. Sreedharan
St. 694	R. Rajagopal	St. 808	G. M. Parkett
St. 699	N. Sundararajan	St. 813	M. George
St. 712	S. R. Kapur	St. 818	P. C. Joso
St. 715	S. Singh	St. 819	R. Radhakrishnan
St. 721	C. L. Bagga	St. 825	B. Gari
St. 726	H. L. Sharma	St. 832	Narayanjee Mishra
St. 742	Chittaranjan Shrivastava	St. 839	V. M. Naidu

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A

(Existing Scheme)

Roll No.	Name of candidate	Roll No.	Name of candidate
2A	B. Jeswantlal Bhatt	82A	B. V. Venkata Subbiah
7A	K. M. Joshi	84A	V. I. Tarakaraman
11A	B. N. Attara	91A	Swaminatha Rajagopalan
19A	Govind N. Jotwani	93A	P. S. Ramabhadran
36A	Satish Chander Gupta	97A	B. Venkatasivaramaiah
41A	Aniyath Achuthan	99A	S. N. Moorching
51A	Srinivasa Ramaswamy	102A	Md. Abdulla Basha
54A	L. Ramagopal	103A	B. N. Sreenivasa Murthy
55A	M. R. Visveswaraiah	107A	Sreevastan Sriranganathan
59A	A. L. Chandra Sekhara	115A	B. K. Vijayagopal
60A	H. B. Ramakrishnaiah	116A	K. Nagaraj
61A	H. A. Mohan	121A	A. T. Poovanna
65A	Doddachowdaiah	123A	D. Vasudevalu
66A	N. C. Nandakumar	125A	Kaup Jeevandhar Ballal
67A	T. L. Lakshmipathi	128A	Alagirisamy Srinivasan
72A	K. R. Chandra Sekhara	130A	C. Irshad Ul Haque
74A	M. S. Ramaswamy	132A	M. K. Ranganatha Rao
75A	B. S. Satyanarayana	134A	C. R. Satyanarayana Setty
79A	P. S. G. Raju	136A	S. R. Kumara Gupta
81A	H. G. Srinivasa Rao	138A	Purushottam Singh Malik

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
139A	K. Chirayil
140A	V. Krishnan
144A	Dattaram Rawaji Patil
146A	B. R. Subramanya
149A	Shantnand Chaubey
151A	Achanta Sridhara Rao
157A	S. K. Murthy
158A	T. V. Srinivasarangachar
161A	M. Srinivasan
162A	K. Shankaranna
163A	Raya Narayan Railkar
169A	P. M. Mohana Rao
177A	Gali Munikannama Naidu
184A	Putthur Narayanan Gopal
195A	Raparti Veerraju
197A	S. P. Palanivelu
201A	Vinod Prakash Misra
204A	Brij Raj Singh
206A	N. F. Gajjar
207A	Yeshwant Rajaram Jathar
220A	N. N. Trivedi
230A	M. K. Shukla
236A	Pralhad Hari Nemade
237A	I. P. Katyal
241A	Mrinal Kanti Banerjee
242A	C. C. Bose
253A	Dayanand Mandal
256A	D. K. Bandyopadhyay
258A	D. N. Sinha
262A	S. V. Gunaji
264A	Surjit Singh
267A	Anant Dattatraya Bhide
268A	S. Dalal
269A	S. K. Kakkar
274A	Ayodhya Nath Chaturvedi
276A	Sita Ram
280A	Surendra Kumar
285A	Nagendra Prasad Saxena
286A	J. Hanumant Rao Naidu
287A	Uma Shankar Tiwari
288A	Thomas Mathew
291A	R. Sankaranarayana Aiyar
295A	Om Prakash Jally
297A	N. R. Balasubramaniam
299A	Charanjit Singh Chaman
304A	Krishnagopal Kumari
305A	G. Ganesan
306A	Bikram Singh Goel
309A	N. C. Misra
310A	V. K. Kukreja
312A	Kuldeep Singh Sachdev
313A	Satya Paul Gambhir
314A	Vivekanand
326A	Mahanth Rai
331A	Bahadur Singh
332A	T. V. Sampath Kumar
333A	H. S. Satyanarayana
336A	Phul Singh Panghaal
340A	Hari Shankar Pandit
356A	Natesa Subramanian
357A	N. Dhana Sekaran
361A	Abdul Razzaq Khan
363A	Buddh Singh Kushwaha
364A	V. S. Pradhan
365A	K. C. Roddappa Chetty
366A	S. C. Bhamb
368A	Sukhdev Raj Khanijo
373A	S. Dhundiraj Sapre
374A	Dinavahi Sree Rama Rao
377A	Babulal Jain
378A	Nirmal Chandra Karnawat
380A	K. Seshadri
381A	S. A. C. V. Chainulu
384A	Jayanti Shankar Sharma
385A	S. Suryanarayana
386A	Raj Narain Agrawal
388A	Yash Paul Saggi
392A	Manmohan Singh Chopra
394A	Sham Lal
398A	Rajinder Singh Chhabra
411A	Jasbir Singh Bhalla
412A	Ponnambalam Natesan
414A	Manohar Vishram Alwe
415A	Amrit Pal Singh
420A	Ramesh Purushottam Kamat
424A	M. B. Pathak
434A	R. S. Desai
435A	Prem Kumar Jettley
453A	Dhas Balachandra
463A	Vijay Trimbak Raste

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
464A	M. H. Purandare
470A	Ajitsingh Manubha Rana
477A	Raghavachari Sundararajan
479A	A. Murugesan
480A	Sham Lal Goyal
481A	Krishna Shambhoo Wagle
486A	Yeshwant Hari Prabhu
489A	Premdhar Lal Shrivastava
490A	Maya Ram Sharma
492A	S. G. Orpe
495A	Ram Lal Gupta
496A	A. G. Iyer
497A	V. H. Bhukhanwala
499A	Suhas Rangrao Kulkarni
500A	M. N. Karmarkar
505A	M. L. Yagnik
507A	L. D. Wahegaonker
518A	N. Srinivasan
522A	Dayal Balchand Varandani
532A	R. V. Pradhan
535A	Mukund Nahar Damle
538A	M. T. Pathak
541A	Ram Pher Mishra
543A	Gopal Shankar Subhedar
548A	Bishan Singh Chakrayet
553A	Ansari Mohamed Ilyas
559A	Santan Singh Negi
560A	Shivaji Shankar Rokade
565A	M. M. Malhotra
566A	Prabhat Kumar Rawat
571A	Vinod Chandrakant Donde
572A	V. H. Kulkarni
577A	Vasant Daji Lad
579A	Prabhakar Narayan Bapat
582A	M. S. Seshadri
584A	Arvind Vaman Apte
587A	Vinayak Gangadhar Bapat
592A	Arvind Dattatraya Gupte
596A	Srinivasaiyengar Gopalan
599A	Janardan Krishna Jadhav
600A	Ramesh Shivram Sohani
602A	Gurmukh Lakhomal Masand
612A	K. S. Murthy
614A	Pemmaraju Sitarama Murthy
617A	V. D. Phatak
620A	M. Padmanabha Pillai
621A	S. V. Kulkarni
622A	Achyut Neelkanth Sathe
626A	A. Hariharan
631A	S. L. Kolhapure
633A	R. Kumar
636A	Adhir Kumar Mitra
641A	C. P. Balachandran
644A	Samir Ranjan Sanyal
647A	Subhas Kanta Mukherjee
652A	Sudhindra Kumar Biswas
654A	Milan Kumar Sarkar
655A	Paritosh Roy
661A	Dilip Kumar Sil
674A	N. R. Chakraborty
678A	Sourendra Nath Ghosh
680A	Arun Kumar Ghosh
687A	Animesh Kumar Mitra
694A	Debesh Chakrabartty
696A	Bholanath Bandyopadhyay
700A	G. Adhya
712A	Ramen Chandra Garai
714A	A. M. Ranganathan
716A	S. P. Roy Chowdhury
719A	T. D. Sharma
721A	A. R. Ramachandran
732A	S. Bhattacharya
734A	Ajoy Kumar Roy
735A	Shib Das Bhar
742A	Ramendra Roy Chowdhury
743A	Kalidas Pal
747A	Nirode Bihari Das
772A	Amal Chandra Roy
781A	P. K. Bhattacharjee
783A	Shyam Lal Rathi
786A	Narendranath Chakrabarti
791A	Lakshmibrata Sarkar
792A	Biswanath Das
799A	J. K. Chaudhuri
810A	Sisir Ranjan Das
816A	S. N. Mukherjee
818A	Amitava Bhattacharya
819A	Basudeb Bagchi
820A	Basudev Chattopadhyaya
822A	Deb Ranjan Dutta

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
826A	Bimalendu Sinha Roy
840A	K. R. Kurup
846A	Chandi Das Bondyopadhyay
852A	Soumen Mitra
854A	Amal Kumar Bhattacharyya
861A	B. N. Mukhopadhaya
862A	Chittaranjan Roy
867A	Dilip Kumar Mitra
868A	Buddhadeb Roy
869A	Sanjit Kumar De
871A	Prithvi Raj Kapoor
874A	Ashok Kumar Banerjee
876A	Prasanta Kumar Datta
880A	Sribas Chandra Saha
881A	Bibhas Kumar Panja
884A	Mohan Mukhopadhyay
892A	T. K. Mookhopadhyaya
893A	Amarendra Nath Dan
894A	Sisir Kumar Mandal
896A	Sukumar Datta
897A	N. C. Sinha
906A	A. K. Sen Gupta
908A	S. Ghosh Roy Chowdhuri
911A	N. K. Bhattacharyya
915A	Sanat Kumar Kundu
919A	Nimai Chand Biswas
923A	Naresh Ranjan Bhowmik
938A	Amulya Ratan Sarker
943A	Pankaj Kumar Mitra
945A	Pulaka Nanda Baksi
951A	Dilip Kumar Samanta
956A	Chand Krishan Sobti
958A	Som Parkash Kapil
959A	Surender Kumar
962A	H. S. Bedi
976A	Mohinder Paul Goel
979A	Satya Paul Saralia
998A	Gian Prakash
1009A	Gurbakhsh Singh
1010A	Gurbachan Singh
1016A	Surinder Singh Bedi
1020A	Shri Bhagwan Sharma
1021A	Yash Pal Goel
1023A	K. L. Dey
1024A	Shankar Govind Gulvani
1025A	Krishan Lal
1027A	Desaraju Rama Mohana Rao
1032A	B. Sri Kumar
1036A	A. Satyendra Prasad
1037A	Narendra Nath Sahoo
1047A	Bansi Dhar Pherwani
1057A	A. K. Agrawal
1059A	S. P. Sabharwal
1062A	Vijay Prakash Gupta
1065A	Yog Raj
1066A	Vasudev Krishan Bhatia
1068A	Bhim Sain
1074A	Abhinandan Kumar Jain
1081A	Autar Krishna
1085A	Manohar Lal Chadha
1097A	Kailash Chand Sabharwal
1103A	Ram Niwas
1104A	Mangat Rai
1105A	Madan Kumar Suri
1109A	Nand Lal
1110A	Daya Shanker Dixit
1111A	R. N. Sharma
1119A	P. D. P. Srivastava
1120A	Kuldip Singh
1123A	Yoginder Singh
1138A	Balam Awasty
1142A	Ashok Kumar Saxena
1144A	K. Dev
1145A	Kali Charan Misra
1146A	J. S. Vilkhu
1149A	P. N. Pandey
1155A	Krishan Kant Bahl
1157A	Ram Sarup Bhatia
1159A	Shri Krishna Kaushik
1168A	Man Mohan Krishan
1170A	Narendra Kumar Jain
1173A	C. B. Kumar
1174A	Satya Pal
1177A	Raj Singh Nirman
1179A	Surendra Mohan Sharma
1181A	Suraj Bhan Singal
1190A	Ishwar Chand Chutani
1209A	Suresh Chander Bhatia
1210A	M. R. Ahuja
1218A	Narendra Vir Chopra

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
1219A	Anand Swarup Kaushik
1220A	Narinder Nath Behl
1239A	C. R. Dargan
1241A	Narendra Sahai Saxena
1243A	Perminderjit Singh
1249A	Vijay Bharadwaj
1250A	Naresh Chand Sharma
1257A	Mahendra Kumar Goel
1262A	B. R. Goel
1269A	Madan Lal Abbrol
1272A	Mohan Kisharam Java
1275A	Amar Singh
1280A	Jagan Singh
1284A	Surendra Kumar Jain
1285A	Sarjit Singh Humjan
1292A	P. S. Chadha
1305A	Vierender Kumar Mahendra
1306A	Dalip Singh
1308A	Om Parkash
1317A	Birhama Nand Gupta
1319A	Satya Bhushan Narula
1324A	K. L. Uppal
1328A	Vinod Kumar Puri
1333A	Gulab Das Burman
1335A	Hitesh Chandra Kashmiria
1337A	Mohan Lal Gupta
1338A	Ramesh Chandra Sanwal
1341A	Raghbir Chand Dheer
1345A	O. P. Nayar
1347A	Kulwant Singh Anand
1348A	Prahlad Singh Malhotra
1352A	Chaman Lal Kaul Aima
1361A	R. Kumar
1363A	Virendra Paul Joshi
1369A	Krishan Lall Batra
1371A	Harikrishan Khurana
1375A	K. C. Rana
1381A	K. N. Kapoor
1382A	Kanwal Nain Seth
1388A	M. G. Khaneja
1390A	V. K. Mittal
1394A	Brijendra Singh
1396A	Tara Chand Kumar
1397A	Satya Prakash Sharma
1404A	Satish Kumar Gulati
1407A	Har Bhagwan Prabhakar
1410A	Ravi Prakash Talwani
1411A	Arjun Chetandas Chandnani
1414A	Avtar Singh Ahluwalia
1416A	R. S. Sagar
1421A	Nanik Ram H. Asnani
1427A	Goverdhan Lal
1432A	Gyan Prakash Garg
1438A	Hari Prakash
1441A	Ramani Bhushan Bal
1446A	Paritosh Chakravorty
1448A	Arabinda Kundu
1449A	Amiya Kumar Palit
1450A	Niranjan Kumar Pal
1451A	Manindra Nath Pal
1455A	S. K. Guha
1460A	Ganes Chandra Choudhuri
1461A	Suresh Chandra Gupta
1462A	S. R. Choudhury
1463A	Harihar Ghosh
1469A	Dibakar Das
1471A	Suhrit Krishna Ghosh
1473A	Dharam Vir Chugh
1475A	Krishnapada Das Chowdhury
1476A	Kashmiri La
1481A	Nand Lal
1493A	K. N. Ghose
1495A	Ibrahim Madhur
1496A	Manotosh Bose
1498A	Adhir Chandra Dutta
1501A	Ajit Kumar Mitra
1505A	Anath Bandu Sarcar
1507A	A. N. Sur
1514A	Ramasubramanian Narayanan
1523A	Nagesha Rao
1531A	K. S. Baba
1534A	A. S. Hanumantha Rao
1538A	Tumuluri Subrahmanyam
1552A	Javvaji Atchaiah
1554A	Koneru Tulasidas
1556A	N. V. Ramana Murty
1563A	Athuri Radha Krishna Rao
1566A	Kallam Venkatappa Reddy
1572A	Chotyal Abdul Hameed
1579A	S. A. Rahman

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
1583A	Wudali Venkatachalapathy
1585A	K. V. Parvati
1588A	T. Sreerama Murty
1590A	Chatar Singh
1591A	G. R. Auradkar
1596A	G. Kanakaiah
1597A	A. Ramasubbaiah
1609A	Jinka Subbarayudu
1616A	Mopidevi Basava Rao
1620A	Syed Ibrahim
1624A	Govind Prasad Dubey
1627A	P. Subba Raju
1633A	R. N. Khandekar
1634A	S. K. Bhattacharjee
1635A	B. D. Kumbhakar
1640A	Subash Kumar Chatterjee
1642A	V. Krishna Swamy
1658A	Devraj Khurana
1659A	Balai Chandra Ghoshal
1663A	Harjindra Singh
1664A	Baldev Kumar Kukreja
1665A	Santosh Kumar
1671A	Vilas Narayan Kulkarni
1672A	Suresh Chandra Agarwal
1674A	R. S. Bulchandani
1675A	Madho Swaroop Saiwal
1684A	Dharmu Gurnani
1685A	Anand Kumar Gupta
1695A	D. M. Tejwani
1697A	Narain Sunderdas Badlani
1699A	Dina Nath Pahooja
1700A	Ramnik Lal Mehta
1702A	Bhagwati Lal Mantri
1719A	V. D. Didwania
1721A	Moti Ram Raisinghani
1724A	Radha Kishan Sharma
1734A	Jagdish Chandra
1737A	Hem Prakash
1743A	Gopalrai Teumal Chatwani
1744A	Vishwambhar Modi
1757A	Om Parkash
1770A	G. P. Srivastava
1781A	A Ramakrishna Rao
1782A	H. Pranesha Rao
1783A	C. C. Bhattacharyya
1791A	Pashupati Nath Sinha
1795A	Gopal Chandra Banerjee
1799A	P. D Singhal
1801A	S. P. Vyas
1806A	Satya Prakash Khatri
1809A	Shyam Sunder Shukla
1815A	Narendra Kumar Mittal
1816A	Surendra Kumar Jain
1824A	Chandra Mohan Saxena
1825A	Krishan Mohan Garg
1830A	Hanwant Singh Lunker
1834A	Suraj Pal Singh Rana
1840A	Jagjit Singh
1858A	I. S. Suhag
1860A	M. N. Narayana
1865A	S. B. R. Misra
1867A	Swamy Ramakrishnan
1868A	M. Lingaswamy
1872A	Brahmanand P. Motwan
1877A	S. P. Maini
1882A	Shyam Narain Shukla
1883A	Govind Mohan Sharma
1885A	Suresh Chandra Khare
1889A	Tarak Nath Gupta
1890A	B. S. Sidhu
1892A	Kilaru Seetharamaiah
1896A	Ramendra Nath Trivedi
1905A	Gora Chand Ghosh
1906A	Nirmal Prakash Vig
1908A	Padam Chandra Jain
1909A	Naresh Chandra Sharma
1912A	Krishan Lal Chopra
1934A	Ram Bharos
1937A	Santosh Kumar Panday
1938A	Sharda Prasad
1941A	S. N. Mukerji
1942A	Ranvir Singh
1943A	Jagdish Chander
1951A	Chain Sukh Das
1952A	V. P. Nigam
1953A	Charan Singh Varma
1955A	A. R. Bhat
1959A	Surendra Kumar Khanna
1960A	Vidya Bhushan Nangia
1962A	Shyam Nandan Lall

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
1970A	Raghunath Singh
1974A	Gurdial Singh
1985A	R. C. Arora
1986A	Surender Kumar Tuli
1993A	R. P. Srivastava
1995A	Sarwan Singh Gill
1999A	Gurnam Singh Grewal
2004A	Joginder Singh Thakar
2016A	K. K. Bassi
2018A	Dwarka Nath Sharma
2019A	Nand Lal Arora
2029A	Mulk Raj Bedi
2031A	L. C. Jain
2044A	K. M. George Kutty
2047A	Subramanya Krishnamurthy
2050A	Dandamudi Raja Rao
2051A	K. Srinivasan
2055A	Panchapakesan Viswanathan
2056A	P. Laxminarayana Bhat
2061A	J. Sankaran
2063A	Nistala Suryanarayana
2073A	Pratti Subbramaniam
2081A	S. K. Ramasubramanian
2083A	Bimal Kanti Bose
2090A	T. R. Balakrishnan
2095A	Muhammad Salahuddin Ahmed
2102A	Vangupuram Raman
2107A	C. L. Vadhani
2108A	C. V. N. Rao
2111A	V. Srinivasan
2119A	S. V. Veeraraghavan
2120A	S. Chandra Sekaran
2134A	C. V. Rami Reddy
2140A	R. A. P. Sastry
2143A	B. N. Marigowda
2144A	H. S. Rajamohan
2146A	N. S. Dore
2152A	Santhana Gopala
2153A	G. Madhavan Nair
2154A	S. K. Ramanathan
2157A	N. Keshav Prasad
2162A	S. N. Shirwadkar
2164A	S. J. Sahasrabodhe
2173A	Vishnu Ramchandra Munshi
2186A	M. V. Mulay
2187A	N. N. Sahatpure
2192A	K. N. Karandikar
2194A	R. S. Tiwalkar
2206A	R. Viswanathan
2207A	Chakram Srinivasan
2208A	Chakrapani Ramaswamy
2213A	A. R. Venkatakrishnan
2214A	John Thomas
2215A	Mahadevan Sundararajan
2216A	V. S. Aliyar
2217A	R. Rajappan
2220A	K. Kalyanasundaram
2222A	V. Venkataramani
2224A	Manni Venkatesan
2238A	A. Thiruvengadam
2239A	Chockalingam Manickavelu
2246A	Ajit Singh
2251A	Harindhar Singh Sidhu
2253A	Nirbandhan Kumar Joshi
2254A	Tej Prakash Sharma
2256A	Suresh Chandra Gupta
2266A	Charanjit Lal Garg
2269A	Karm Paul Singh
2291A	Harmohinder Singh Bhatia
2292A	Pawan Kumar Garg
2293A	Chiranjive Lal
2310A	Pashupati Singh
2314A	Sheo Shankar Singh
2325A	Gopal Krishna Mittal
2331A	Hardeo Singh
2345A	M. Ram
2348A	Trilok Shankar
2350A	Badri Prasad
2351A	Chandra Mauleswar Prasad
2352A	Brahma Deo Sharma
2353A	Lakshmi Narain Sinha
2354A	Bhim Narain Saha
2360A	Santosh Kumar Sharma
2362A	M. Sambasiva Rao
2366A	V. G. Chhatre
2367A	S. Arunachalam
2368A	Sitaram Dasharath Patil
2369A	Jayant Madhav Gokhale
2370A	M. Lal Chopra
2372A	C. K. Gakhar

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
2373A	M. S. Raghunandan
2379A	S. N. Rokade
2382A	Thakur Ganesh Singh
2397A	A. Raman Menon
2398A	Malempati Satyanarayana
2402A	C. M. Dabak
2404A	Divakar Vasudeo Pendse
2411A	Mohammed Yousuf Kumte
2417A	K. C. Pandyaji
2421A	N. V. Kulkarni
2428A	Rajaram Sadashiv Ranade
2431A	Prabhakar Trimbak Sathbhai
2433A	Sudhindra Gunderao Desai
2441A	Sharad Kesho Kulkarni
2447A	P. B. Matnani
2450A	Hussan Lal
2451A	Hanamant Dinkar Godbole
2453A	Padmakar Dhondopant Panse
2459A	P. K. Nair
2460A	P. C. Roy Karmakar
2465A	S. N. Cherekar
2470A	Baliram Krishna Gangawane
2474A	Mahesh Pal
2484A	Dinakaran Asirvadham
2487A	A. V. Ambedkar
2496A	S. B. Sharma
2497A	Lakshmi Kanta Samanta
2509A	Barun Kumar Banerjee
2510A	Mrinal Kanti Roy
2511A	Akhil Pada Sarkar
2513A	Om Prakash Verma
2514A	Raj Kumar Duggal
2515A	Hrishikesh Narayan Singh
2518A	Seshagiri Krishna Dikshit
2521A	Diwakar Nath Srivastava
2526A	Bali Ram Singh
2527A	Jitendra Kumar Popli
2533A	Prakash Chandra
2536A	Shiam Lal
2537A	Madan Lal Rajput
2538A	M. R. Srivastava
2545A	Shiv Narain Khanna
2546A	Om Parkash Chaudhry
2550A	Surendra Kumar Jain
2555A	Jagjit Singh
2556A	Keshav Chandra Naithani
2562A	Tara Datt Padalia
2575A	Arumugham Thiagarajan
2582A	Biswanath Sahu
2587A	Kumar Swami Chaturvedi
2604A	Satish Chandra
2608A	Awtar Singh Azad
2616A	Autar Krishen Mandloo
2619A	S. Rama Iyer
2621A	Miss Beena Thomas
2625A	T. Rengaiyer Krishnan
2626A	Kakkanattu Cherian Mathew
2628A	Mathai Thomas
2630A	T. Sivaraman
2632A	K. P. Unnikrishnan Nair
2640A	S. R. Nair
2643A	V. Balakrishnan
2649A	K. C. Geevarughese
2650A	K. Mukundan Pillai
2652A	C. S. Sathyaseelan
2656A	Janardhanan Jagadeesan
2659A	B. Sesha Iyer
2662A	K. Murugiah
2670A	K. K. Nambudiri
2672A	G. R. Murthy
2676A	K. Ramakotaiah
2680A	A. V. K. Suryanarayana
2683A	Peddada Suryaprakasa Rao
2686A	P. Lakshminarayana Rao
2692A	B. Rama Murty
2698A	V. R. Rao
2700A	S. Vysyaraju
2701A	K V. Ramappa Murty
2702A	Karri Krishna Reddy
2706A	R. M. Rao
2714A	S. T. G. Krishnamachary
2716A	P. B. Kawadkar

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B

(Existing Sheme)

Roll No.	Name of candidate
2B	Jagan Nath Sharma
3B	Ambalal Desaibhai Patel
5B	K. Subba Rao Srinath
6B	M. C. Venkatesh
8B	T. N. Srikantan
11B	B. A. Doraswamy
13B	S. R. Shankaranarayana Rao
15B	Madhava Narasimha Dambal
22B	Nagesiah Bala Krishna
23B	M. Gopalakrishna Menon
24B	Prem Parkash Puri
27B	H. V. Prahlada Char
34B	N. V. Chandrashekhara
39B	Satya Narain Sharma
43B	V. Lakshminarayana Rao
44B	Mohammed Abdul Jabbar
45B	C. S. Parthasarathy
49B	S. Sthanu Subramoniam
55B	S. V. Gopalakrishnan
59B	T. E. Krishna Swamy
67B	D. V. L. Narasimha Rao
71B	Behari Vallabh Trivedi
74B	C. Narasimhachar
76B	P. F. Doshi
79B	Laxman Mukundrao Bapat
81B	A. F. Vasanwala
83B	Gopichand Ishardas Bhatia
87B	Madhav Narhar Kelkar
91B	S. Raju
92B	Vadakkedath Mahadevan
97B	Kamal Chandra Gupta
98B	Balwant Sitaram Godbole
105B	S. B. Limaye
110B	C. S. Gavandi
111B	Suresh Chintaman Das
113B	Ghanshyam K. Makhijani
114B	V. B. Paradkar
117B	Anand Prakash
120B	J. A. Bharwada
122B	V. N. Mukundan
123B	Rachakonda Rama Sastry
124B	Amiya Kumar Ghosh
126B	R. N. Banerjee
127B	R. K. Chopra
128B	Paritosh Ghosh
129B	T. K. Ghosh
132B	Nimai Kumar Das
133B	Sambhunath Banerjee
134B	Nitai Chandra Kundu
135B	Shyamal Kumar Sengupta
137B	Dipak Kumar Ghosh
138B	Prajesh Kumar Chakraborty
139B	Chandi Das Mallik
140B	Sree Krishna Ganguly
142B	Kanchan Kumar Dutta
143B	Champak Kumar Bose
144B	N. Ganapathy Subba Iyer
146B	Dipak Ranjan Ray
148B	Dipak Sen Gupta
149B	Alakendu Bandyopadhyay
150B	Sudhindra Kumar Adhikari
151B	Subha Bindu Das Gupta
155B	Debes Kumar Bhattacharjyo
157B	Arun Kumar Bose
160B	Dharam Bir Chopra
163B	R. S. Viswanathan
166B	Hara Dhan Pollya
169B	Parshu Ram Choudhary
170B	Ved Parkash Bhanot
171B	Shyama Prosad Mukhopadhya
176B	S. N. Chakrabarti
177B	Ghanshyam Mishra
178B	Dharam Pal Selhi
179B	Rajinder Singh Bhatia
186B	Dinabandhu Mishra
190B	Jagtar Singh
192B	Narayan Chandra Mishra
196B	Ram Nath Billa
203B	Om Prakash Gupta
206B	Bakhshish Singh
211B	Riaz Ahmad Quaraishi
213B	Rajendra Kumar Sardana
214B	Tilak Raj Mediratta
221B	Prem Prakash Dhingra
223B	Om Prakash Gupta
224B	Kehar Singh
225B	Sunder Singh
226B	Swaran Singh Virk

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B—*contd.*

Roll No.	Name of candidate	Roll No.	Name of candidate
227B	Khem Raj Khosla	340B	Romesh Chander Kohli
229B	Shabda Prakash	346B	Makkapati Gurucharanam
230B	Harsaran Singh Bhatia	348B	N. Rangaswamy
233B	Baldev Raj Sahni	356B	Tadimalla Ramamohan Rao
235B	Mohinder Pal Chawla	358B	M. Unnikrishna Variar
236B	H. Natarajan	360B	Mulupuru Venkateswara Rao
237B	Santosh Kumar Saksena	363B	V. R. Reddeppa Chetty
238B	Prithi Raj Sharma	367B	M. Shivavarma Raja
247B	Narain Singh Sardana	369B	T. M. Ravindranathan
248B	Harbans Singh	373B	P. S. R. A. Vital Rao
251B	Baljit Singh Nayar	377B	S. Sankaran
254B	K. R. K. Murthy	379B	K. N. Krishna Prasad
256B	T. S. Nagarajan	389B	S. Abdul Rahim
265B	Kunduri Kama Raju	392B	P. Joseph Thomas
272B	Atluri Visweswara Rao	393B	J. V. R. Subbarao
276B	P. Radha Krishna Murthy	394B	D. P. Rao
279B	L. Bhavani Prasada Rao	395B	V. Ramaswamy
282B	Andaluri Umamaheswara Rao	396B	Kailash Chander Chhatwal
285B	Bhimadolu Subba Rao	398B	Om Prakash Verma
286B	Gajula Krishna Rao	399B	Satindar Mohan Kharabanda
288B	Kolavennu Narasimha Babu	400B	Jaspaul Singh
289B	M. Moinuddin	401B	Padam Sen Jain
291B	K. Satyanarayana Setty	407B	Suresh Prasad Srivastav
292B	B. Lakshmana Rao	409B	Mahishi Bindumadhavachar
295B	Payyavula Ramanna	414B	Ram Vilas Singh
299B	M. Abdul Salim Siddiqui	417B	N. S. Yakkundi
300B	L. Sankaranarayanan	419B	Y. G. Brahme
301B	Basant Kumar Goswami	421B	Kishan Singh Khandka
303B	Hukam Chand Gupta	422B	Bosukonda Venkata Rao
305B	Shiv Dayal Sharma	425B	S. M. Talekar
307B	Balbir Singh Basur	428B	Shravan Vithal Patil
309B	V. S. Patnaik	433B	Raj Kumar Jain
313B	Suraj Narayan Bansal	434B	Ram Bilas Gupta
314B	Kali Charan Misra	435B	Brij Nandan Sud
315B	Om Prakash Agrawal	447B	C. S. Ramachandra Murthy
317B	Gurmeet Singh	452B	Krishan Seetharaman
319B	Rajendra Prakash Agarwal	456B	T. R. Vaitheeswaran
321B	Anand Parkash Bhandari	461B	K. M. Ravindran
322B	M. P. S. Kushvaha	463B	N. Chandrasekhara Menon
324B	Narinder Kumar Chandna	465B	Ryali Ramachandra Rao
327B	Subodh Behari	468B	Paruchuri Sudarsana Rao
329B	V. Bahadur	475B	M. Pundarikaksha Rao
334B	V. K. Kotra	477B	Mulaparthi Ramakrishna
336B	Hoshiar Singh Sachar	478B	Y. Srihari Rao
338B	A. S. Basmay	482B	N. C. Reddy
		483B	H. Parameswaran

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A

(New Scheme)

Roll No.	Name of candidate
28NA	M. S. Ughreja
47NA	A. L. Bhatt
50NA	Mohan Pribhdas Tulsani
72NA	Avinash Chander Saini
78NA	T. Subbaramakrishnan
87NA	S. Prasanna
88NA	L. S. Rao
90NA	Surjit Singh Dhaliwal
97NA	P. Muthu Swamy
102NA	M. Venkataraman
107NA	K. Ananthanarayanan
116NA	N. S. Sathyanarayan
120NA	B. V. Varadarajan
134NA	U. Venkat Rao
147NA	D. N. R. Swamy
168NA	R. S. Rao
174NA	P. Chiranjeevi Sharma
179NA	B. V. Achyuthrao
185NA	K. S. Nagaraja
192NA	M. Suryanarayanaswamy
196NA	K. V. S. Sundar
233NA	H. S. V. Murthy
272NA	V. N. Ganapayya
277NA	A. S. Jayaprasad
305NA	V. Kumara Swamy
307NA	B. P. Shastri
338NA	L. C. Anandamurthy
366NA	K. S. Thunga
370NA	P. V. Nanda Kumar
393NA	M. R. V. Gopala Das
421NA	Narayan Chandra Das
433NA	M. S. Jagannathan
478NA	K. Vonkataraman
493NA	P. Rama Rao
500NA	M. M. K. Reddy
529NA	M. S. Kuppaswamy Iyengar
581NA	Sujan Singh Kamra
628NA	Alakh Narayan Mehta
639NA	Ramashish Singh
659NA	P. V. Ramachandra Murty
734NA	K. R. Dewangen
740NA	S. S. Bhargava
761NA	T. K. Srinivasan
765NA	Pritam Singh Guglani
766NA	K. G. Gupta
771NA	Murari Lal Gupta
788NA	G. P. Gupta
815NA	K. V. S. Iyer
860NA	M. L. Aggarwal
903NA	Shashikant Tambane
932NA	Inder Lal Bhatia
952NA	Sanat Kumar Jain
1003NA	A. R. Dixit
1047NA	Hari Prasad Chourasia
1151NA	Dipak Kumar Basu
1157NA	M. S. Allaudeen
1199NA	Thomas Varghese Kutty
1210NA	Vishram Gopal Karmarkar
1283NA	S. Dharmarajan
1365NA	K. A. Krishna Moorthy
1484NA	Amalendu Chattopadhyay
1527NA	Umapada Chakravarty
1529NA	Birendra Chakrabarti
1535NA	Ranadeb Mukhopadhyay
1564NA	Shashthi Charan Roy
1632NA	Arunendu Sen
1635NA	D. D. Gangopadhyay
1655NA	Jaibir Prasad Sah
1667NA	K. Das
1693NA	P. K. Sarkar
1702NA	Sib Sankar Dhole
1731NA	P. K. Sarkar
1734NA	K. C. Bharadwaj
1784NA	Priyaranjan Sengupta
1801NA	R. C. Jhanwar
1850NA	Dipak Sarkar
1939NA	S. R. Viswanathan
1952NA	Sakti Pada Pan
1974NA	P. Viswanath
1981NA	S. K. Dutta
2010NA	Uday Biswas
2011NA	Priyatosh Majumder
2020NA	Ramlal Singh Yadav
2027NA	S. P. Datta
2046NA	P. Kar
2079NA	Bansi Badan Saha
2238NA	Paritosh Paul
2246NA	Nishat Kumar Trivedi

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
2285NA	Amrit Lal Saini
2308NA	Parkash Chand Snehi
2317NA	Rajinder Singh
2342NA	Manmohan Singh
2347NA	M. Singh
2353NA	Charan Jit Allawadhi
2487NA	Harjit Singh
2552NA	A. Sahu
2553NA	Bishnu Charan Sahoo
2554NA	Devaraj Nayak
2556NA	B. K. Misro
2577NA	N. Nanda
2598NA	N. Mohanty
2607NA	Bichitrananda Naik
2650NA	Yudhisthir Prusti
2686NA	Bimala Prasad Patnayak
2711NA	Prasanna Kumar Pradhan
2712NA	R. Mishra
2715NA	Somanath Mohapatra
2742NA	Sridhar Swain
2758NA	Jaswant Singh Yadav
2813NA	S. Kumar
2839NA	K. N. Simha
2846NA	S. S. Lall
2900NA	R. S. Palahyia
2913NA	Shiv Nath
2917NA	Sukhbir Singh Maini
2983NA	Karam Jit Singh
3019NA	M. P. Kashyap
3051NA	C. M. Aggarwal
3092NA	K. J. S. Rudra
3096NA	R. Deo
3124NA	V. P. Kaushik
3147NA	Parkash Chand Jain
3148NA	B. Nandan Singh Chauhan
3151NA	B. S. Kainth
3208NA	M. C. Sethi
3217NA	Ram Karan Gupta
3218NA	V. P. Gupta
3257NA	R. M. Sharma
3266NA	N. Badrinarayanan
3282NA	H. S. Bhatti
3318NA	Jeshtha Nand Madan
3341NA	Raj Pal
3386NA	Deo Swarup Sharma

Roll No.	Name of candidate
3421NA	S. L. Verma
3437NA	Prem Vardhan
3469NA	Sudhir Gajbhiye
3572NA	Sushil Kumar Madan
3673NA	Narinder Mohan Ghai
3791NA	A. B. Karmakar
3805NA	B. C. Maji
3850NA	S. Dutta
3852NA	D. C. Jana
3869NA	I. K. Vadera
3870NA	Subhash Chandra Dutta
3872NA	J. C. Majumder
3875NA	Paresh Chandra Saha
3885NA	Nani Gopal Aich
3929NA	Shiv Kumar Yadav
4018NA	J. R. C. Murthy
4019NA	Mahender Pratap Jayanni
4020NA	Govind Ram Modi
4022NA	A. Husain Khan
4025NA	S. S. Kshatriya
4029NA	T. Jagannadham
4032NA	D. M. Rao
4042NA	M. N. Raveendran
4048NA	U. Sudhaker Rao
4054NA	P. Suryanarayana
4063NA	Janardan Sharma
4097NA	Y. R. Rao
4105NA	Mohd. Farooq
4106NA	Syed Baseerul Hasan Razvi
4122NA	Shiva Narayan Yadava
4124NA	A. R. Chaturvedi
4149NA	Vangala Narsimha Rao
4211NA	V. L. Narasimha Rao
4227NA	M. Jayaramireddy
4265NA	G. A. Jairaj
4279NA	M. A. Qyoom
4287NA	P. Munaswamy Naidu
4288NA	P. Balakrishna Shenoy
4298NA	N. R. Rao
4312NA	Bhattiprolu Pasupathi Ram
4372NA	H. D. Dawra
4412NA	S. R. Jawlekar
4457NA	Mohan Keshav Kanade
4507NA	S. C. Saxena
4577NA	Mata Prasad Mishra

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
4591NA	Naresh Kumar Garg
4592NA	Gokul Singh
4653NA	Govind Narain Mathur
4661NA	Radhey Mohan Gupta
4715NA	H. Chandrashekara Udupa
4717NA	B. K. Nag
4788NA	S. Srivastava
4793NA	Gurmukh Singh Khalsa
4813NA	S. C. Sharma
4820NA	Manohar Lal Sharma
4896NA	Krishna Chandra Agrawal
4908NA	A. M. Mukhopadhyay
4914NA	Suresh Chandra Gupta
4922NA	S. R. Agrawal
4936NA	Surya Pal Gupta
4937NA	Iqbal Singh Bhatia
4941NA	S. K. Butta
4952NA	Yashendra Pal
5003NA	M. P. Goel
5042NA	Suresh Chand Jain
5106NA	Avinash Swaroop Mathur
5196NA	S. C. Verma
5198NA	Mithanthaya Sripathy
5399NA	G. J. S. Sibota
5429NA	Tirath Ram
5490NA	Bhushan Lal
5518NA	S. K. Singh
5526NA	J. C. Buber
5537NA	Koshal Nath Mehta
5557NA	K. B. Tripathi
5560NA	H. Sadruddin
5564NA	C. B. Singhal
5571NA	V. Parthasarathy
5576NA	Kishore Chandra Sahoo
5578NA	C. Ramachandran
5579NA	S. S. Manoharan
5583NA	S. R. Krishnan
5584NA	A. Harish Menon
5588NA	G. Soundararajan
5594NA	S. C. Sekaran
5597NA	R. S. Patil
5600NA	R. B. Narasimhan
5612NA	P. K. Mishra
5614NA	T. K. Srinivasan
5617NA	M. P. Pillai
5620NA	Hari Har Dash
5630NA	K. J. Chacko
5632NA	G. Vaitheeswaran
5646NA	R. Madanagopal
5656NA	M. M. Balasubramanian
5676NA	B. C. Mohan
5689NA	D. Sidda Reddy
5704NA	S. Subramanian
5707NA	G. Parameswaran
5714NA	K. Rangarajan
5715NA	A. Kuppuswamy
5735NA	S. Dhandapani
5745NA	K. N. Viswanathan
5776NA	V. M. Venkiteswaran
5818NA	V. D. Narayanan
5867NA	S. Thiagarajan
5874NA	R. Manivannan
5892NA	K. Uthama Gopala Krishnan
5901NA	D. S. N. Rao
5917NA	P. Sankaranarayanan
5935NA	B. R. Rao
5949NA	Tara Prasad Ray Chaudhuri
5968NA	K. V. Lakshminarayana Setty
5971NA	T. S. Krishnamurthy
6021NA	S. L. Hete
6037NA	B. Vyankatesh Karulkar
6041NA	Manohar Mukund Dandekar
6043NA	Vishwa Prakash Sharma
6065NA	B. S. Kene
6078NA	S. P. Lampuse
6093NA	R. N. Vyas
6105NA	G. V. Godbole
6118NA	C. Vaithiyanathan
6160NA	George Kurien
6167NA	L. Ramamoorthy
6173NA	V. V. Subbiah
6191NA	Ramanathan Srinivasan
6228NA	M. K. Sriraman
6307NA	H. S. Dhillon
6350NA	Krishan Lal Sethi
6374NA	Mahesh Chandra Gupta
6380NA	Jagdish Rai Goyal
6406NA	Des Raj Goel
6407NA	G. S. Gill
6415NA	Rajendra Kumar Johar

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
6418NA	Des Raj Khurana
6449NA	Indra Deo Tiwary
6451NA	Binay Kumar Sinha
6454NA	Bijoy Bahadur Singh
6513NA	Ram Sakal Prasad
6547NA	B. G. Mhetre
6549NA	Y. Krishna Murthy
6583NA	A. R. Baburao
6612NA	P. V. Tukaram
6645NA	M. P. Damodar
6711NA	P. H. Lala
6727NA	K. V. L. Narayanamurty
6775NA	D. Ramanjaneyulu
6851NA	Meka Subbarao
6860NA	Vetcha Satyanandam
6863NA	Mahendra Singh Tyagi
6866NA	Shiva Ram Singh
6888NA	Nani Gopal Das
6898NA	R. D. Sood
6972NA	S. P. Saluja
7029NA	Chander Singh Sharma
7066NA	B N. Verma
7085NA	J. M. Khanna
7122NA	Dilip Kumar Bhadury
7203NA	Chakresh Kumar
7247NA	Durga Nath Kotha
7253NA	J. L. Koul
7267NA	M. V. Kuriako
7292NA	Lukose Philipose
7302NA	S. R. Chandrasekaran
7325NA	G. N. Nair
7351NA	P. K. Joseph
7376NA	C. I. Gopi
7403NA	M. Rajababu
7427NA	B. H. Rao
7465NA	I. Malakondaiah

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B

(New Scheme)

Civil

Roll No.	Name of candidate
12NB	E. Natarajan Krishnamurthy
21NB	B. R. Govinda Rao
27NB	B. S. Manje Gowda
45NB	N. D. Tandon
69NB	Kishore Krishna Rao
71NB	J. K. R. Soni
73NB	N. T. Makhijani
81NB	Siddiqui Salahuddin Ahmed
143NB	Parimal Kumar Sanyal
187NB	K. Rath
194NB	Santosh Kumar Garg
199NB	Hukum Chand Gupta
201NB	Satya Paul Malhotra
229NB	Chandrasekhar Mishra
230NB	Sumonto Mohanty
234NB	Suresh Chandra Satapathy
241NB	Sricharan Acharya
243NB	Sangram Keshari Sinha
246NB	Upendranath Baral
248NB	Gaura Chandra Mishra
252NB	Bidhu Bhusan Kanungo
271NB	Prabhu Chimandas Chandan
273NB	K. C. Maheshwari
281NB	Ramkishan Gupta
282NB	Rameshwar Dayal
287NB	Ramesh Chander Grover
290NB	Rishi Kumar Govil
292NB	N. S. Ailsinghani
294NB	Milap Chand Bahl
296NB	Byomekesh Bose
300NB	Sushil Kumar Dhawan
305NB	Prem Chand
307NB	Vir Sain Jain
317NB	Babu Lal Agrawal
319NB	Lokesh Chandra Gupta
321NB	Hari Krishan
323NB	Promod Kumar Sahgal
324NB	Vijay Kumar Nanda
330NB	Madan Lal Gupta
332NB	Harkesh Singh Tootia
367NB	Chhotey Lal Gupta
371NB	J. M. Khetarpal
373NB	S. S. Virdi

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B—*contd.*

Roll No.	Name of candidate
376NB	Radha Raman
381NB	S. K. Mittal
415NB	Vasu Dev
436NB	Ram Dial Aggarwal
437NB	C. M. Vij
475NB	V. Kumar
480NB	Bhan Pratap Singh
481NB	Ram Autar
482NB	Surjeet Singh
485NB	Khazan Chandra
525NB	Puthenkulathil Varke
536NB	K. N. Malghan
541NB	A. Vaddi Narayanappa
608NB	Chhote Lal Garg
614NB	Kailash Chandra Sharma
615NB	Subhaschand Jain
616NB	Mulo Menghraj Chhugani
621NB	Kamlendra Kumar Jha
626NB	Amar Nath
646NB	N. J. Somayazulu
653NB	P. V. Gopalan
655NB	B. S. Mathur
675NB	Nand Kishore Agrawal
676NB	Chandra Prakash Arora
679NB	Ram Chandra Pandey
687NB	Satish Chandra
697NB	Mahendra Prakash Agrawal
703NB	Onkar Prasad Saxena
710NB	Shailendra Kumar Jain
712NB	Suraj Prakash Ahuja
722NB	Hari Mohan Singh
723NB	Prem Shanker
727NB	Shakti Kumar
739NB	Jagjit Singh Ahuja
771NB	Chaman Lal Kochhar
789NB	T. Ranganathan
798NB	Ramaswamy Thirunarayanan
800NB	Dhruba Chandra Sahoo
802NB	B. K. Das
806NB	S. Subramanian
818NB	A. P. V. Nair
829NB	S. Sadasivan
835NB	Ayodhya Prasad Chourasia
859NB	Ramamoorthi Nagarajan
890NB	Baleshwar Prasad Sinha
895NB	Shukdeo Barhi
912NB	S. Jha
917NB	S. P. Mahto
919NB	Mukund Ramchandra Ambike
930NB	Mukund Moreshwar Deshmukh
945NB	Prabhakar Balaji Katakkar
950NB	Sudhakar Dattatraya Dake
977NB	Chandradip Singh
1001NB	Brij Pal Singh
1030NB	T. Kochouseph Joy
1033NB	P. I. Balagopalan
1043NB	Modiyil Mathai John
1048NB	Chembolli Ravindranathan
1050NB	T. R. Madanagopalan
1063NB	Surendra Panda
1069NB	Chatlapalle Ramana Rao
1077NB	K. R. Raju
	Mechanical
1085NB	H. S. Rangarajan
1090NB	B. K. Sreenivasan
1094NB	Coca Raviprasad
1128NB	K. S. Desikan
1129NB	Rajendra Pal Nadar
1130NB	Jagannathan Jayaraman
1131NB	Rangachar Kuppaswamy
1132NB	M. S. Vasudevan
1168NB	Umesh Wagle
1169NB	K. S. Ramaswamy
1198NB	Manohar Lal Agrawal
1209NB	Sudhakar Khare
1219NB	G. R. V. Prabhu
1227NB	Madan Pal Sharma
1230NB	S. C. Bhattacharya
1248NB	Amrit Paul Chaba
1278NB	Vanka Madhava Rao
1301NB	P. K. Roy Chaudhuri
1327NB	Samarendra Basak
1344NB	P. V. John
1377NB	Om Parkash
1392NB	Fakir Mohan Sahoo
1403NB	V. K. Luthra
1406NB	Ramesh Kumar
1428NB	K. D. Puri
1461NB	S. C. Acharyya

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B—*contd.*

Roll No.	Name of candidate
1467NB	V. S. Mudennavar
1472NB	Govada Edgar Jayakumar
1479NB	M. Varda Rajeswara Rao
1482NB	Mocherla Lakshminath
1495NB	Jagdish Singh Jangi
1500NB	D. S. M. Sarma
1519NB	Komal Parkash Sahni
1542NB	G. B. Kulkarni
1548NB	D. S. Ramachandra Murty
1575NB	Ram Chet Singh
1588NB	Jai Narain Awasthi
1626NB	G. Ganesan
1628NB	T. N. Sathyamurthy
1634NB	R. Rajasekar
1637NB	R. Balaraman
1644NB	T. Rajagopalan
1647NB	Ramachandraiyer Rajamani
1650NB	L. V. Subrahmanyam Reddy
1652NB	Kalarikal Savier Joseph
1653NB	Shivji Ram
1655NB	Rabhavachari Narasimhan
1665NB	Nanjan Sivan
1668NB	T. S. Subbarathinam
1673NB	C. R. Krishna Murthy
1680NB	Piara Singh
1688NB	Sukumar Mukherjee
1734NB	V. K. Venkataraman
1735NB	M. L. Goel
1736NB	Shashi Bhushan Prasad
1741NB	Moti Lal Dhar
1744NB	N. V. Ramalingam

Electrical

Roll No.	Name of candidate
1763NB	P. V. Ganesan
1782NB	P. Purandar Rao
1786NB	P. E. Sankaranarayanan
1803NB	H. S. Ahluwalia
1805NB	T. V. Gopalan
1814NB	Peri Subrahmanyam
1820NB	A. V. Rama Mohana Rao
1839NB	Rameshwar Dass Gupta
1848NB	Lal Chand
1859NB	Ved Parkash Garg
1872NB	Tarsem Lal
1899NB	N. Pundalikrao Fulari
1905NB	Bomanji Nauroji Adajania
1919NB	T. S. Venkataramani
1923NB	S. Roy Chowdhury
1932NB	Subramanian Venkatesan
1969NB	Joginder Singh Kohli
1996NB	Sham Dass Mehta
2007NB	Inder Jit Gandhi
2010NB	Sham Kumar
2085NB	Vajrala Krishnaiah
2107NB	K. Anantharama Prabhu
2111NB	Balvindar Singh Sidhu
2117NB	Satya Prakash Dixit
2133NB	Harbinder Singh
2153NB	K. Mahadevan
2157NB	R. Thiruvenkatachari
2166NB	Mohamed Ismail Sait
2200NB	Kashmiri Lal Garg
2216NB	Srinivasan Venkatesan
2227NB	M. G. Jain
2255NB	Y. S. C. M. Rao

Chemical

Roll No.	Name of candidate
2260NB	G. S. Parthasarathy
2269NB	Jiwat Bhagchandani
2272NB	Saranathan Ramadurai
2273NB	Thakar Singh
2274NB	Ram Parkash
2280NB	Chittaranjan Sarkar
2281NB	Siladitya Ghosh

Metallurgical

Roll No.	Name of candidate
2287NB	Devaraj
2297NB	S. K. Ghosh Chaudhuri
2298NB	Asish Kumar Sarkar
2301NB	Bhupal Chandra Sensarma
2303NB	Tarunesh Chandra Maitra
2313NB	Jarmeja Trilochan Singh
2316NB	Virendra Kumar Dikshit
2317NB	A. V. Balachandran
2318NB	P. K. Sanyal
2320NB	Chitta Ranjan Chakraborty
2321NB	Ramaswami Santhanam
2322NB	Harbhajan Singh
2327NB	Pratty Subba Rao

Electronics & Telecommunication

Roll No.	Name of candidate
2347NB	S. Iyer Srinivasan
2348NB	M. Shamrao Kumara Shankar
2358NB	Daivendar Kumar Sud

EMPLOYMENT SERVICE

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In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

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YOUNG ENGINEER, Graduate Member of both The Institution of Civil Engineers and The Institution of Structural Engineers, with seven years experience in P.W.D. and five years experience with a London Consultant as R.C. Designer-Detailer, wants to join a civil and structural consultant or contractor in Calcutta at four-figure salary per month. Write K. Ray, 192 Galliard Road, London, N. 9., U.K.

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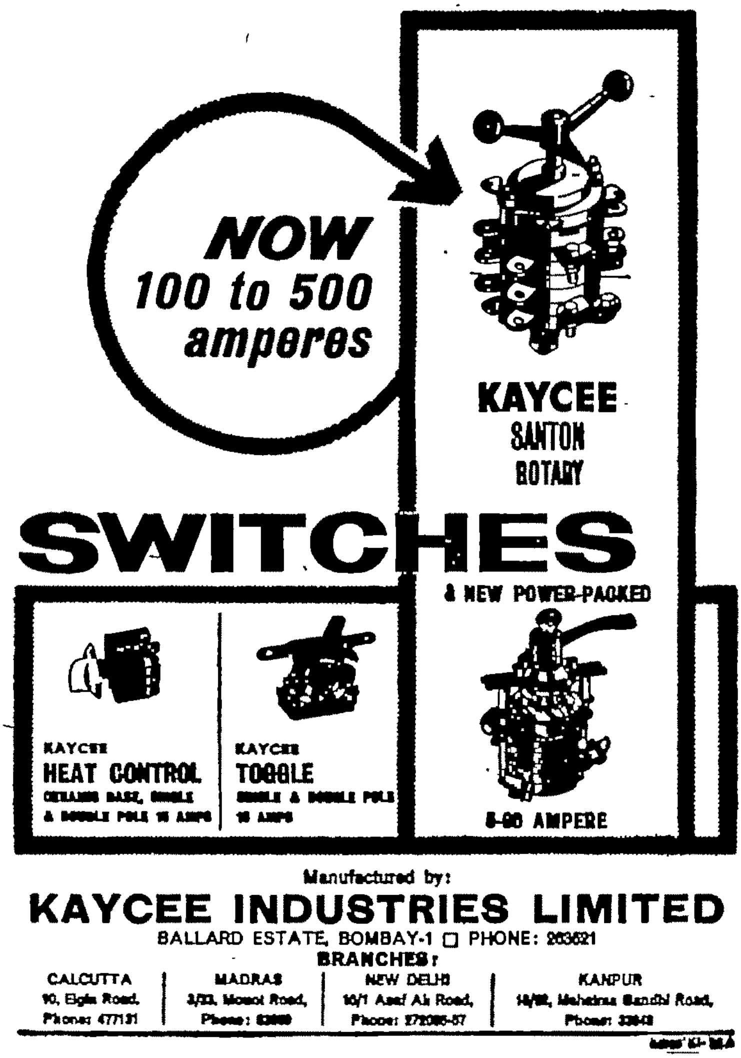

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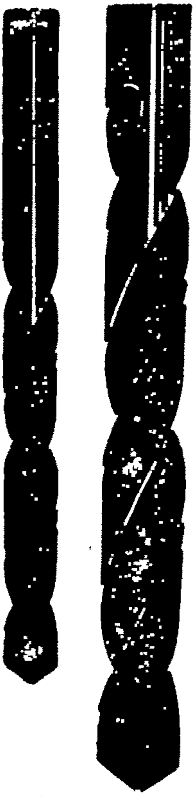

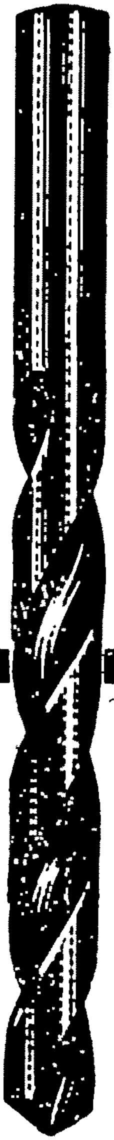

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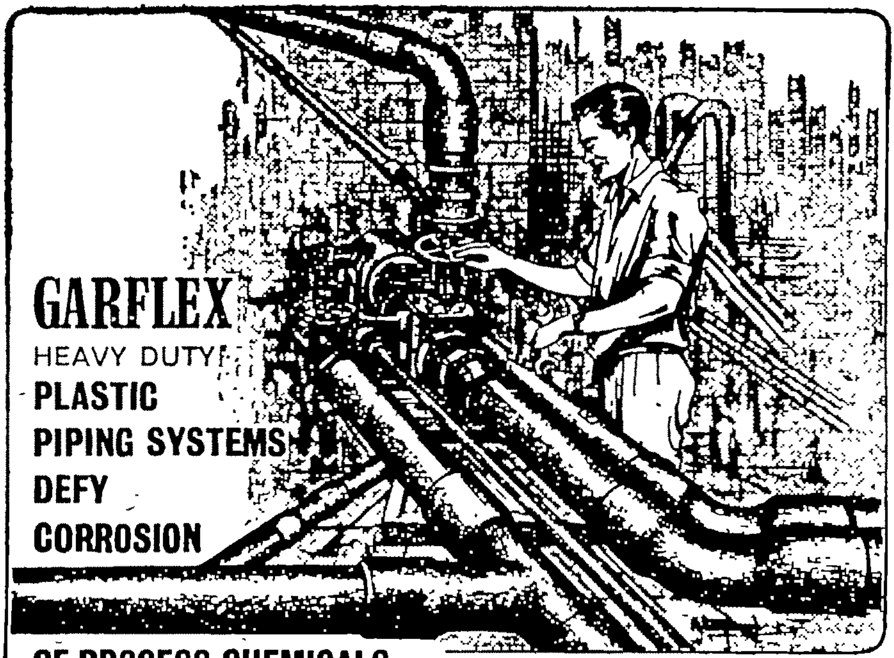

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AN INTRODUCTION TO BIO-ENGINEERING*

J. G. Bodhe

Member

1. Introduction

All scientific researches are with a view to understand the laws of nature, so that, these can be utilised to serve the humanity. Efforts of scientists and engineers have, therefore, been directed to study the physical laws and are connected mostly with inanimate things. Scientists have advanced up to fission of atom and have come to a stage of interplanetary space travel.

On the other hand the dictum 'Know thyself' has only been partially satisfied. The continuous quest of the physiologists, scientists, chemists, biologists and engineers in unravelling the functions of the human body itself still ends in a mystery. Therefore, the science combining engineering with physiology and medicine has a very important place in the search for truth and knowledge and can be designated as bio-engineering or medical engineering.

2. Definition of bio-engineering

Bio-engineering, therefore, is an attempt to combine the engineering aspect of the human creation with and as interwoven and interdependent on the biology of a human being. This science is extremely complex, indeterminate and unpredictable, due to the fact that human being consists of living materials, full of life, ever growing and full of complexes very difficult to measure, standardize or predict. Bio-engineering, therefore, aims at applying structural, mechanical, electrical, chemical and electronic engineering to human body or any other living animal and to study its implications in the God's master creation, *i.e.*, life.

3. Fields covered by bio-engineering

3.1. Bio- or medical-engineering has become one of the most rapidly growing fields of research in the world within the last few years. The demand for this new discipline results from the obvious need for quantitation in biological areas which have heretofore consisted primarily of large masses of qualitative descriptions, classifications and co-relations of various forms of life and their component organ systems.

3.2. Biologists have collected voluminous information regarding the size, shape, colour, structure, life cycle and distribution of various forms of life. These have been grouped, classified and co-related. A great deal is known concerning what exists in nature and where it is to be found. Remarkably little is however known regarding the basic mechanism of function and control, because comparative physiology is only recently gaining widespread attention.

3.3. The key stone of future development in biology from fish to man will be quantitative analysis based on direct measurements of critical variables. Medicine has been primarily an art depending largely on signs and symptoms co-related with pathological processes and relies on clinical observations and opinions of authorities unsupported by evidence. Rapid technological advances provide us with tools for scientific research with transdusors, amplifiers, telemetry equipments, high frequency recorders and high speed computors.

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* A talk delivered at the 46th Annual Convention, Patna.

3.4. The engineering aspect of bio-engineering encompass the following:

a. The application of electrical and electronic engineering principles and techniques to measurement and study of life processes.

b. The conceptual adaptation of the structural and functional properties of living systems to the problems of engineering designs.

3.5. Bio-engineering can be utilized for:

a. Developing new instructions or techniques for the diagnosis and prognoses of disease.

b. Developing new instruments or techniques for therapeutic purposes.

c. Developing new assistive devices (wheel chairs, iron lungs, hearing aids, 'Sonar' type locomotion to the blind) and corrective devices (orthoses), and replacement devices for lost organs (prostheses).

d. Modifying or controlling the environment.

e. Devising engineering analogs of biological system (bionics), cybernetics.

f. Applying physical laws to the study of biological processes.

4. Merging of sciences

A decade ago mathematics, physics and engineering were three distinct areas of interest. The lines of demarcation between these three scientific disciplines are rapidly becoming obscure.

4.1. This trend towards the unification of sciences extends to biology and medicine, through rapid emergence of bio-physics, bio-engineering and bio-mathematics. These new subjects mark an important step in conversion of biology and medicine into quantitative science, although the bio-mathematics, bio-physics and bio-engineering inter-mingle into each others' fields.

4.2. Scientists in ever increasing number must develop multilateral competence in quantitative fields. Engineers and physicists are frequently frustrated when they enter the field of biology. The problem implicit in the study of living organism can be exemplified by contrast between measurement of length of a metal rod and the length of an earth worm. The length of a metal rod changes in response to alterations in temperature. This, however, could be controlled, while the length of an earth worm changes in response to a large number of factors. The control of the length of an earth worm would require interference with its normal functions. Thus recording our measurements of living things are complicated by their multifarious normal functioning.

5. Action of stomach

5.1 Having mentioned the background and the scope of bio-engineering it would be profitable to examine the various functions that are carried out in the human being, by the heart, the kidney, the stomach, and the brain, etc., from the engineering point of view; and also to try to understand the automatic built-in control systems, such as the control of temperature of the human body by thermostat system, control of various functions in the human beings by electronics in the brain, other automatic controls of valves, respiratory organs, etc.

The digestion of food is a complex operation being a combination of mechanical churning and chemical action of dissolving the food by digestive liquids. After the food reaches the stomach, its movement ceases to be direct. Muscular contractions shift it back and forth, slowly dividing a bolus into parts, squeezing the parts into smaller portions, and all the while, covering the newly exposed surfaces with digestive secretions.

5.2. It is only on surfaces that enzymes can act. If, for example, a spherical mass of food 4 cm. in diameter is divided by muscular action of the stomach into two equal spheres, the total volume remains the same but the surface areas exposed to digestive agents jump from 50.1 to 83.2 sq. cm. If each of these is divided equally again, so that four spheres result, the total volume is unchanged but the surface area of the four spheres now totals 79.5 sq. cm. Thus as a food bolus is divided progressively in half by volume, its surface area progressively increases in the ratio of 1:1.26:1.59:2.00: 3.17:5.05:6.35:8.0:10:05, and so on. A sphere offers the least surface area per unit of volume. In any other form, the increase of surface area is considerably more rapid as the bolus is divided.

6. Food and energy of life

6.1. We know, what it is to feel full of energy; perhaps, even to greater extent we are familiar with feelings of exhaustion. In a general sort of way we also know that our 'energy stores' are in some way related to our intake of food. It is only recently that an understanding of 'springs of energy' within the living body has been gained. Discovery of the secret sources of energy of life and mechanism by which this energy is made available and harnessed brings with it an understanding of some of the central features of the living process.

6.2. We know that potential energy and the kinetic energy of a body are mutually interchangeable. A third sort of energy is the heat energy. These energies, however, are not reversible in a human being.

6.3. The Interplay of hydrogen and oxygen is perhaps the key to human energy. This is the particular instance of an atomic change which the body makes use of. Hydrogen has a spare electron and the oxygen two empty spaces. The electron drops away from the hydrogen atom into the empty space of the oxygen atom awaiting to receive it. This movement is the root cause of all the body's energy. The oxygen passes in our body through lungs, and from there to other parts of the body by hemoglobin of the red blood cells. Hydrogen, however, is the constituent of all our food. This is how the interaction of hydrogen and oxygen takes place which generates the energy required for life.

6.4. In addition to the above, there is the energy which we get from the light especially from the Sun's rays through the complex mechanism called photo-synthesis. In fact, therefore, the oxygen and hydrogen and the sun's rays are the sources of energy for the extraordinary process of life.

6.5. Conversion of food by chemical and other processes into the complex production of heat and other form of energies is extremely difficult for measurement. However, the expenditure of energy could be measured. The chemical process involved in life varies greatly with activities. Thus, a man weighing 150 lb. transfers heat to the surrounding air at approximately following rates:

		Calories per hour
i.	while sleeping	65
ii.	awake but lying still; muscular tension and mental activity	75
iii.	resting but sitting in a chair	100
iv.	light muscular exercise, such as writing or playing cards	170
v.	moderate muscular exercise, such as walking on level ground	300
vi.	heavy work, such as climbing mountains, lifting rocks, digging ditches, pitching hay, running rapidly	600

It is possible to calculate the number of hours per day at each type of activity and to compute the total number of calories of heat liberated. The number of calories of heat liberated should never be more than number of calories taken in by way of food during the corresponding period.

6.6. At any given temperature, the energy requirements are governed to a considerable extent by the weight of living protoplasm, by the degree of activity, and by the opportunity afforded for a heat loss.

In spite of longer periods spent in sleep, four children weighing 40 lb. each use up far more energy each day than one parent weighing one hundred and sixty pound. Part of this is used in growth, but a large proportion of energy is lost, because the smaller individual has relatively more surface for radiation of heat, in proportion to its volume and the weight of the body in which a chemical activity proceeds.

Few people know how much surface they present to the world. This can be calculated using Du Boi's formula for the area of the naked body. If S is the area in sq. meters, W is the weight in kilograms, and H is the height in centimeters, then

$$S = 0.00718 \times W^{.425} \times H^{.725}$$

A man weighing 184 lb. and 6ft. 4in. tall will have a surface area of 22.7 sq.ft. while one weighing 128 lb. and 5ft. 6in. tall will have 17.5 sq.ft.

Food requirements are approximately proportional to these surface areas. There is slightly higher rate of energy expenditure in human females as compared with males.

Mammal	Pulse rate at rest, beats per min.	Blood temperature, °F.	Respiration rate per min.	Adult weight, lb.
Mouse	328-780	95-100	84-230	0.05
Rat	261-600	95-100	100-120	1
Rabbit	140-160	102	55	7-12
Cat	120-140	101.7	24	7-12
Dog	70-120	101-102	15-20	7-40
Pig	70- 80	101-103.5	8-18	900
Sheep	70- 80	104-105	12-20	100-140
Man	60- 80	98.8	15-20	100- 200
Lion	40- 50	98.6	10	580
Dromedary	30	83-104	—	990
Horse	30- 45	100.2	8-10	900-1,100
Cow	40- 70	101.5	10-30	1,000-2,000
Elephant	25- 47	97.6*	5	12,000-13,000

* Heat production from the skin (2 calories per sq. in. per day) is the greatest known in any warm-blooded animal ; the skin is about 10 degrees cooler than the blood temperature shown.

7. Temperature regulation

7.1. Metabolic heat is put to use and automatically controlled, in all living bodies. Heat from muscular contraction (plus about one-tenth arising from other metabolic and glandular activity) is distributed by the blood stream to all parts of the body From the body surfaces it radiates away or is lost by conduction and convection. If the heat loss becomes more rapid than the heat production, the blood temperature drops slightly. This affects a thermostat-like mechanism in the second region of the brain, and initiates an increase of nervous stimulation to the smooth muscles of the intestine and of the major blood vessels, and generates overall tension of the skeletal muscles. This increased contractile activity may liberate enough additional heat to match the heat loss, bringing blood temperature to its 'normal' level. If it does not, still greater muscular tone may give rise to irregular spasmodic contractions of many skeletal muscles, followed by the involution act of 'shivering.' Still more heat is generated by this greater violence.

8. Hydro or haemostatic pressure

8.1. The gravitational force of attraction of a body to the earth is given by *mg*, where *m* is mass in grams, and *g* is acceleration in cm. per sec^2. This is the force by which one gram mass is attracted to the earth at sea level.

Let us examine the problem introduced by the simple fact that the man's head is 6 ft. away from his feet and still he walks upright. The two fluids circulating independently in the body are blood and lymphs. Both move in a canal system very intelligently designed on principles of hydrodynamics. This is comparable to our water supply schemes in huge cities, but much more economical, scientific and efficient. The blood circulates in a close system driven by the heart pump. The lymph is driven by muscle movements along its canals.

8.2. Because a column of air 6 ft. high and 1 sq. in. in cross-section has negligible weight, there is no difference in weight of air at the head and feet. However, the weight of this column of blood of 1 sq.in. is 2.8 lb., and is quite a considerable proportion of the atmospheric pressure of 14.8 lb. per sq.in. at the foot level. This extra pressure at the feet due to the weight of blood is therefore 2.8 lb. per sq. in. Hence the heart must force blood against the back pressure, taking into consideration the friction in the large arteries and veins; the total area of flow is relatively small but the rate of flow is very high.

8.3. The heart is a pulse pump; it distends, collecting a volume of blood, fresh from the lugs, closes its inlet valve, contracts, forcing the blood out through the aorta.

8.4. The aorta has elastic walls which expand under hydraulic force generated by contracting heart muscles. The pressure, therefore, rises in the aorta which may vary from 30 to 150 mm. of mercury. A maximum value of this pressure is called the systolic pressure, which is of the order of 120 mm. The minimum value after the walls of aorta have discharged the blood is called the diastolic pressure, which in an adult male is 80 mm. of mercury. Because the veins in the legs are more easily distended than the arteries, most of venous blood is stored there and recalled when needed. The centre of gravity is thus lowered, and storage, therefore, requires less work.

.8.5 The osmotic pressure *P*, varies directly as the concentration (*i. e.* number of moles *n* per volume *V*). Where *R* is the universal constant and *T* the absolute temperature, note the analogy with the ideal gas law

$$P\,V = n\,R\,T$$

Hence the former could be considered to be an ideal law for solutions.

As the cell walls become stretched, the restoring pressure (the wall being elastic, like a balloon) applies a mechanical pressure on the liquid. An equilibrium is reached at which

$$P_i = P_o + P_r$$

where the *P*'s are osmotic pressure inside and outside the cell, and P_r is the restoring pressure of the walls of the distended cell. Table below gives a quantitative illustration of this important point

Balance between osmotic pressure difference and restoring pressure in cell walls.

Ion content of red blood cells (meq/l):				
Na^+	138	Cl^-	105	
K^+	4.5	HCO_3	25	
Ca^{++}	5.2	Protein	16	Total: 149.7
Mg^{++}	2.0	PO_4^{-3}	2.2	$P_o = 7.4$ atm.
		$SO_4^{=}$	0.5	
		Remainder	1.0	
Ion content of blood plasma (meq/l):				
Na^+	16	Cl^-	55	
K^+	96	HCO^-	15	Total: 117
Ca^{++}	0.5	Other ions	47	$P_r = 5.7$ atm.

$P_r = P_o - P_i = 1.7$ atm. (25.5 lb. per sq. in.) exerted by stretched walls of cell. If cell radius is 10 (10^{-8} cm.) total forces exerted by stretched cell wall is only 0.00005 lb.

9. Memory concept and implementation

9.1. The mind stores all the information. Physical machines can be made to do similar work through:

i. Magnetic tapes or magnetic pores

ii. On or off relays

iii. Slow penetration processes in which electric or sonic signals bounce around and inside crystals for a time before escaping; and

iv. Electro-chemical devices such as capacitors.

In fact the machine can be programmed to collect information while it is operative, and use it thereafter, thus closely simulating man's memory.

9.2. The recent theory about the physical nature of our neural memory apparatus is that the repeated passing of electrical signals distorts RNA molecule for a time sufficiently long, to give the oddly shaped protein molecules an opportunity to synthesize. This then slips into chemistry of the cells and perhaps later affect the rate of a neural reaction which guides the switching pattern, which is called 'memorising'. The machine can be taught a rudimentary classification, and thereafter to classify appropriate inputs. That a machine could be made which can take random information and develop a classification is not impossible; it is just excruciatingly difficult.

The question whether a machine can be made which will be able to develop a concept or abstract idea is destined to remain unanswered for a foreseeable future.

10. Control mechanism of brain

10.1. Comparing the modern computer with the man's brain as units of control, we see that the both can accept, store, and re-deliver information, and in this way can learn more.

Both can do logical argument that is based on premises, do arithmetic and solve equations. Both can issue commands which result from logical arguments and can restrict feed back which tells whether or not the commands are being successfully carried out.

There are however major differences. The brain is usually able to find alternative routes to accomplish a task, if the direct route is physically damaged. Generally, mal-function of one component of the machine will stop its operation totally, although Ashby's machine was said to have sufficient paralleled circuits which could be tripped at random, and the machine could still function.

Machines are generally much more accurate and faster than men at computations. Machines, however, have not yet been made which can do abstract mathematics, or do pattern recognition other than rudimentary classification. On the interesting subject of self-control or self-determination which implies judgment of what is good and bad, and free choice to do either nothing can be said of the future of the machines. How does the brain actually do the job of controlling the human body so finely? The answer seems to lie in models and accurate instrumentation.

11. Digital and analog computer in the brain

11.1. A human being has control mechanism in his brain which might be described in the same terms as used to describe digital and analog computers.

11.2. The neuronal circuit which switches is about a billion times smaller than vacuum tube circuits and a million times smaller than a transistor circuit and at times even smaller than thin films which are now within the research stage. Further, the number of components in the brain is about million times the number in the largest computer. Therefore, it is certain that quantitative description of the control circuitry of the central nervous system is far beyond our reach.

11.3. It is easy to build an analog computer with a precision of about 1 in 1,000; harder to build one with 1 in 10,000 and impossible to build with 1 in 1,00,000, because machining of parts and electrical measurements cannot be made with such precision.

Since the central nervous system operates with about 10,000,000,000 (ten billion) components or neurons for its digital and analog facilities, the problem of understanding our nervous system is obviously not easy.

11.4. Because of its potentiality in computer technology there is considerable interest in the techniques of storage and retrieval of information in the brain. A number of possibilities have been proposed, such as re-circulation loops, affixed synaptical junctions through a gestalt mechanism, wherein all cortical processes involve all neurons. Memory is conceived of as complex inter-connections of neurons forming patterns or paths where a given neuron is involved in more than one path.

11.5. The objective of this kind of work is to seek new techniques for solving engineering problems from the data obtained from the electronics of brain to engineering problems.

11.6. The question about information and control in human beings and the man's brain which combines digital and analog computer machinery faster and accurate by billion times than that of mechanical computer, makes us wonder whether this subject could at all be mastered and studied by human beings. It makes us wonder how insignificant we human beings are, compared with God's creation.

12. Scale in nature and limiting size of animals

12.1. Everywhere nature works true to scale and everything has its proper size.

Man and trees, birds and fishes, star and stary systems, have their appropriate dimensions and their more or less narrow range of absolute magnitude. The scale of human observation and experience, however, lies within narrow bounds in inches, feet or miles; all measured in terms drawn from our own selves. Scales which include light years, parsecs, angstrom units or atomic magnitude belong to other orders of things.

12.2. A common effect of scale is its impact on the physical forces, some of which act either directly at the surface of a body, or otherwise, in proportion to its surface or area. While others, and above all gravity act on particles, internal and external alike, and exert a force which is proportional to the mass and, usually, to the volume of the body.

12.3 The forces exerted by weight are proportionate to their masses, and these to their volumes and hence to the cubes of the several linear dimensions. It happens that the forces in action in a system, vary with power, and some other vary as masses. distances or other magnitudes. The relative values alter with the scale. This is known as the Principle of Similitude or Dynamical Similarity.

12.4. Galileo explained that besides the question of pure stress and strain, the important question of bending moments is involved when we consider the strength required of muscles to lift an increasing weight, or of bones to resist crushing stress. It affects the whole form of the skeleton, and sets a limit to the height of organic or inorganic structure.

12.5 Bones make to 18% of the body of a mouse, or 13 to 14% of a goose or a dog, and 17 to 18% of the body of a man

As the size of an animal increases, the limbs tend to become thicker and shorter and the whole skeleton bulkier and heavier. Elephant and hypopotamus have grown unproportionately to the work-load they do. The bulk of a living thing has to be in proportion to his efficiency, otherwise, in the struggle for existence a bulkier thing has a tendency to vanish. The strength of a muscle like that of a rope or a girder varies with its cross-section, and the resistance of a bone to crushing stress is proportional to its sectional area.

12.6. But in a terrestrial animal the weight which stands to crush its limbs, or which its muscles has to move, varies as the cube of its linear dimensions. Hence, to the possible magnitude of an animal living under the direct action of gravity, there is a definite limit set. The elephant in the dimensions of its limbs and bones is already showing signs of disproportionate thickness and it has, therefore, tended towards maximum limit of size which the physical forces permit. Thus, birds, animals, fish, grow to a size proportional to their functions or their requirements for existence. This is known as the Froude's Law of Dimensional Theory.

13. Analogy of bridge for the construction of skeleton of a quadruped

13.1. Standing four square upon its fore legs and hind legs, with the weight of body suspended between, the quarduped at once suggests to us the analogy of a bridge carried by two piers. In more ways than one the quadrupedel bridge is a remarkable one. Perhaps its most remarkable peculiarity is that it is a jointed and a flexible bridge remaining in equilibrium at the same time flexible. The flexibility is an essential feature in the quadrupedel bridge, while it is the last thing which an engineer desires, and the first which he seeks to provide against.

13.2. So far as the function is concerned, we might compare horse's legs with tall and slender piers of some railway bridge. But it is obvious that these jointed legs are ill adapted to receive the horizontal thrust of any arch that may be placed on top of them. Hence it follows that the curved back bone of the horse cannot be regarded as an arch in engineer's sense of the word. It resembles an arch in form but not in function; for it cannot act as an arch unless it is held back at each end by abutment capable of resisting the horizontal thrust.

13.3. Thus it follows that these simple types of bridges do not correspond to the type of bridge which nature has designed in the skeleton of the quadruped. Nevertheless, if you try to look at the actual design of the skeleton of an animal, and the actual distribution of its load, we find that the one is most admirably adopted to the other, according to the strict principles of engineering construction.

The skeleton is not an arch, nor a tied arch nor a bow string girder but it is strictly and beautifully comparables to the main girder of a double-arm cantilever bridge. Obviously, in our quadrupedel bridge, the superstructure does not terminate at the two points of support but it extends beyond that which carries the head at one end and sometimes the heavy tail at the other end projecting as cantilevers.

14. Anatomy of birds and their wings

14.1. For efficient and perfect mechanism in a bird's anatomy nothing can be more beautiful than the construction of a vulture's metacarpal bone. The engineer sees in it a perfect Warren truss comparable to that used in the wings of an aeroplane Not only that, but the bones are better designed than the truss; for the engineer has to be content to set his *V*-shaped truss, all in one plane; while in the bone they are put, with obvious but inimitable advantage, in a three dimensional configuration

15. Aerodynamic adaptation

15.1. Perfect adaptation in engineering can be traced to the form of a fish for swimming or a bird for flight. This is not the hypothesis but is actual demonstration of mechanical efficiency where statistical and dynamical considerations can be applied and established in detail.

15.2. The naval architect learns a great part of his lesson from the streamlining of a fish; the yachtsman learns that his sails are nothing more than a great bird's wing, causing the slender hull to fly along.

15.3 The mathematical study of the streamlines of a bird, and of the principles underlying the areas and curvatures of its wings and tail, has helped to lay the very foundations of the modern science of aeronautics.

15.4. We know, for example, how in strict accord with the theory (it was George Cayley who explained it) that the wing, whether of the bird or of the insect, stands stiff along its 'leading edge', like the mast before the sail; and how, conversely, it thins out exquisitely fine along its rear or 'trailing edge', where sharp discontinuity favours the formation of uplifting eddies. And we see how, alike in the whale's flipper, the same design of stiff fore-edge and thin fine trailing edge, both curving away evenly to meet at the tip, is continually exemplified.

15.5. We learn how lifting power not only depends on area but has a linear factor besides; a long narrow wing is more stable and effective both for speedy and for soaring flight, than a short and broad one of equal area; and how in this respect the hawkmoth differs from the butterfly, the swallow from the thrush. We are taught how every wing, and every kite or sail, must have a certain amount of arch or 'belly', slight in the rapid fliers, deeper in the slow, flattened in the strong wind, bulging in the gentler breeze and how advantageous is all possible stiffening of sail or wing, and why accordingly the yachtsman inserts 'battens and the Chinaman bamboos' in his sail. We are shewn by Lilienthal himself how a powerful eddy, the so called 'ram' forms under the fore-edge, and is sometimes caught in a pocket of the bird's underwing and made use of as a forward drive.

15.6. We have lately learned how the gaps or slots between the primary wing-feathers of a crow, and a slight power of the wing-feathers to twist, like the slats of a venetian blind, play their necessary part under certain conditions in the perfect working of the machine. Nothing can be simpler than the mechanism by which all this is done. Delicate ligaments run along the base of the wing from feather to feather, and send a branch to every quill as the wing extends. The quills are raised into their places and kept at their due and even distance apart. Not only that, but every separate ligamentous strand curls a little way round its feather, where it is inserted into it; and thereby the feather is not only elevated into its place, but is given the little twist which brings it to its proper and precise obliquity.

15.7. All this is part of the automatic mechanism of wing. There is nothing prettier than this in all anatomy. The triceps muscle, massed on the shoulder, extends the elbow joint in the usual way; but another muscle (along flexor of the wrist) has its origin above the elbow and its insertion below the wrist. It passes over two joints; it is what German anatomists call a *zweigelenkiger Muskel* It transmits to the one joint the movements of the other; and in birds of powerful flight it becomes less and less muscular, more and more tendinous, and hence more and more completely automatic. The wing itself is kept light; its chief muscle is far back on the shoulder; a contraction of that remote muscle throws the whole wing into gear. The little ligaments we have been speaking of are so linked up with the rest of the mechanism, that we have only to hold a bird's wing by the arm-bone and extend its elbow-joint, to see the whole wing spring into action, with every joint extended, and every feather tense and in its place.

15.8. Again on the fore-edge of the wing there lies a tiny mobile thumb whose little tuft of stiff, strong feathers forms the so called 'bastard wing'. We used to look on it as a 'vestigial organ' a functionless rudiment, a something which from ancient times had lagged superfluous on the stage. Until a man of genius saw that it was just the very thing required to break the leading vortices, keep the flow stream-lined at a larger angle of incidence than before and thereby help the planes to land. Hence he invented to his great profit and advantage, the 'slotted wing'.

16. Structural engineering in nature

16.1 It will be interesting to examine the human body as well as the bodies of animals as a work of structural engineer as applied to its stability combined with locomotion.

Human body consists of structural members such as bones which take the compression, and the muscles which act in tension and also contributing to the locomotion by contracting and extending as required. The system of levers is fully and economically utilized in the human body in the functions of fingers, arms, fore-arms, foot, etc. The fullest use is made of hinged joints and ball and socket joints for manoeuvrability. The arm, for example, which is cantilevered out from the main skeleton is an ingenious example of a folded or collapsible cantilever.

The foot of a human being is a perfect example of eccentrically loaded arch which carries the load of the human beings.

The structure of the bone deserves a critical study. It is enlarged to provide wider area to carry any concentrated load. If you examine the interior of a bone you will find that it is strengthened by ribs which follow the lines of stress and is an example of photoelastic demonstration of stress diagram.

The other organs of human body are also expert devices in various branches of engineering.

The heart is an automatic pulse pump which pumps blood into veins and arteries which are an excellent example of design of complicated hydraulic system. The kidney is an example of efficient clarifier containing minimum of the volume. The brain is an unparalleled and unimitable complex of electronics and combines various controls automatic and direct. The thermostat control of the body is a marvel in itself while production of blood is God's mastery in chemical engineering.

Design of animals

16.2. A structural framework of the animals and birds deserves a detailed study. Thus the example of an elephant's skeleton is an application of a tied arch with a cantilever at one end to carry the trunk of an elephant. The skeleton of a horse is a combination of unbalanced inverted arch taking into consideration the cantilever required to carry the heavy head with the result that most of the weight of a horse is carried by the fore legs and only a fraction by the hind legs. The design of a skeleton of giraf is a skilful example of one span beam with a projecting cantilever, at the same time satisfying the statics by sloping the main girder towards the hind legs.

Design of fish

16.3. Fish is an example of streamline construction to afford minimum friction over the surface and aid rapid movement through water. The control of air pressure within the body has given us a clue to submarine design.

Design of birds

16.4 The design of skeleton of birds has very interesting features. The wing of a swan consists of warren girder with the verticals connected to horizontal members by a process of welding

The flying birds have their wings so constructed that the main structural frame is welded together. The mechanism of flights of birds gives us the theories of aero-dynamics, the theory of flutter and the latest innovation of slotted wings for a slow descent of heavy aeroplane.

Design of trees, etc.

16.5 The design of flora and fauna from the structural point of view shows us unlimited areas of interest in structure, economy and efficiency.

17. Further area of research

A tremendous amount of activity and research is being carried out all over the world in all branches of bio-engineering especially applied to human beings. The subject is gaining a tremendous importance due to the problem of knowing human reactions in the inter-planetary space flights. The engineering involved in the human functions when landing on the moon or any other planet, is a domain of special study. In our defence organization where our troops have to operate in the high altitudes of the Himalayas, bio-engineering plays a decisive part. The man's struggle for substituting human parts such as artificial heart, artificial lungs, artificial kidneys calls for long-research, dedicated service and perserverance of unlimited degree. Anaesthesia by electronics and its application in obstetrics is an achievement in bio-engineering.

The following are the items on which researches are being carried out all over the world:

1. Engineering aspects of haemostatic mechanism analysis.
2. Analogy simulation of translents in body temperature regulation.
3. Analog simulation of human thermal equilibrium.
4. Studies of hemo-dynamics.
5. Stresses and strains in human beings due to environments.
6. Bio-engineering in man's space flight.
7. Artificial heart.
8. Instrumentation for research and measurements of bio-medical functions and responses.
9. Movement and composition of cartilage fluid.
10. Quantitive analysis of mechanical stress on biological systems.
11. Mechanical properties of bone.
12. Measurement of forces acting on the hip joints.
13. Application of ultra sound image converters in biology.
14. Engineering aspects of biological control and control mechanism in brain and thermostat application in human body.

15. Engineering in obstetrics.
16. Wave propagation in vascular system.
17. Use of computers in diagnosis.

18. Conclusion

Interpreting man as an organism, complete with his aesthetic emotion, and religious experiences, and as part of a super organism complete with social, cultural and religious activities, we can view man's knowledge of himself, his history, and destiny, in a very broad and intriguing perspective. We know that logical experiments are tools of the scientists, that the logical self-consistency is the final test of the philosophers and mathematicians.

Man's intellectual destiny is to know the truth about the Creator, about the Man, and about the Nature, even though man's body is but all afflicting thing. He has a right to know, ability to find out, and the responsibility to try. Ultimately there is no substitute for the truth in any intellectual discipline.

Man's problem is to find the truth in spite of the noise which troubles him from without and within. There are many pitfalls. Will he find the truth? The answer is not yet known.

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ADDRESSES OF CHAIRMEN AT THE ANNUAL GENERAL MEETINGS OF THE LOCAL CENTRES

Andhra Pradesh Centre

Chairman's address by Lt.-Col. R. S. Attre, B.Sc. (Eng.), E.M.E., M.I.E., at the 28th Annual General Meeting of the Centre on January 25, 1966

After welcoming the Chief Guest, Shri K. B. Reddy, Chief Minister of Andhra Pradesh, and other distinguished guests and members to the meeting, Lt.-Col. Attre thanked the Committee of the Centre for unanimously electing him Chairman for 1966-67.

Delivering the Chairman's address, Lt.-Col. Attre said, 'In the army, we engineers are divided into two broad categories—one dealing with civil engineering which includes buildings, roads, public health engineering and allied subjects. The other dealing with electrical, mechanical, electronic and general engineering. I belong to the second category—the Corps of Electrical and Mechanical Engineers (E.M.E.). The Corps of E.M.E. deals with maintenance, inspection and repair of all electrical, mechanical, optical and electronics equipment.

The role of an engineer in the army also includes that of a soldier, manager and household keeper as distinct from that of our counterparts in the civil life. The work has got to be done during extremes of climate, from sub-zero temperatures of the Himalayan region to 125°F. of Rajasthan; from the dry weather of Delhi to the heavy downpours of Assam.

Here you may well recollect the wonderful work done by our boys in repairing tanks and guns in sugar-cane fields around Khem Karan and Taran Taran, and numerous examples from the last operations. In each case, the work was done right in the face and presence of the enemy without bothering about the enemy bullets, shelling, bombing or strafing, booby trap or mines. The completion of work in time is a very important factor, specially during the war because the delay in repairs of a few tanks, guns or wireless sets could change the result of a battle.

Our E.M.E. support must be there in the forward areas—to keep the equipment in serviceable condition. For this we either send small mobile repair teams called LAD's (Light Aid Detachments) or Field Workshops depending upon the requirements.

Such repair elements 'as mentioned' carry out what is called the light repairs and the field repairs. The nature of work depends upon the available facilities. All these elements have to be mobile. In spite of these difficulties, small units were successful in keeping guns booming on Haji Pir Pass, tanks, guns and wireless sets operating in Sialkot and the Lahore Sectors; vehicles and guns working near Gadra in Rajasthan, and so on.

The improvization, cannibalisation and recovery of equipment are very important aspects of our work.

Here, I may mention a few of the main equipment which will give an idea about the varieties with which an E.M.E. officer has to deal with.

(a) *Vehicles*

  (i) Tanks—light, medium and heavy of different types;

  (ii) Soft vehicles—from motor cycle and jeep to 10-ton vehicles of hundreds of makes and types; and

  (iii) Certain vehicles having cranes and mobile equipment.

(b) *Guns and small arms*

  (i) Mortars, guns and howitzers of various calibres; and

  (ii) Small arms which include rifles, pistols, sten guns, light machine guns, machine guns of innumerable calibres, makes and types.

(c) *Wireless equipment*

  (i) Radio sets of various types and makes; and

  (ii) Radar sets of various types and makes.

(d) *Optical and other instruments*—which includes compasses, binoculars, directors, and instruments like watches, chronometers, etc.

(e) *Miscellaneous equipment*—which may include workshop equipment like lathes, drills and generating sets, etc., and medical equipment.

We have to keep our aim in mind all the time—'to keep all the equipment in a state of operational fitness at all times', which is rightly and adequately exemplified by our motto *Karma Hi Dharma*—also inscripted in our Corps Badge.

In our base workshops we are to carry out job analysis, workstudy material, control and handling, etc., just like in any other factory. An E.M.E. officer functions either as a works manager or a general manager as of any large sized industry. He has to perform the job of an experienced engineer for analysing defects on equipment and then issuing technical instructions regarding them.

The E.M.E. officers are connected with the development of equipment from the very first stage of the design to their introduction into the Services which calls for requisite knowledge, background and vast experience.

As regards training, we train our men right from the recruit stage, and bring them upto the craftsmen's level. The initial training of our men is done at training centres—called E.M.E. Centres. The practical experience is gained in E.M.E. workshops and further training is given by the E.M.E. officers under whom they serve. The theoretical as well as practical training of advanced nature is given in E.M.E. schools and then the men again go to E.M.E. units where they utilize the training they had received earlier and further develop their knowledge.

An E.M.E. officer should be capable of controlling general activities of electrical and mechanical engineering, and for this, either, we get technical graduates from universities, or, we train them. All officers are then trained in organization and in general equipment. Thereafter they are sent to units to pursue their knowledge on actual equipment and come in contact with the men. After this, they undergo advanced engineering courses in automotive engineering, armament engineering or electronics engineering for a period of 1 to 1½ years, and go back to their units.

The E.M.E. officers attend the refresher courses, technical lectures, discussions, symposia and project. An E.M.E. officer of about 15 years experience, undergoes a 'Senior Officers' course of about 4 months to learn the latest techniques, etc., and general handling of E.M.E. units. Also he undergoes military training just like any other army officer and has to pass various promotion examinations. Selected E.M.E. officers undergo 'Junior Commanders' course and 'Senior Commanders' course and some undergo Defence Service Staff College course which is the highest army course, given on the basis of all-India competition.

The E.M.E. officer studies to sort out defects and for designs and modifications. He supervises repairs, gives lectures, carries out recovery work and improvizations, etc., at all places. May I venture to say that actually an E.M.E. officer is truely trying to seek socialism in engineering, and is imparting his knowledge and experience to others; thus trying to improve the technical advancement of the army in particular and the nation in general'.

Bombay Centre

Chairman's address by Shri V. Y. Kamat, B.S. (Engg.), M.I.E., at the 44th Annual General Meeting of the Centre on January 7, 1966.

After welcoming the Chief Guest, Shri Naval Tata, and other invitees, Shri Kamat thanked the retiring Committee of the Centre for electing him Chairman for the ensuing year.

Delivering the address, Shri Kamat said, 'I would like to refer to the critical situation through which our country is passing and how best our engineering fraternity could render service to allay its vigour. After independence, our leaders started planning effective means of eradicating proverty, ignorance, disease and fear from the face of the land with the zeal of crusaders. As the result of the first three Plans, distinct signs of progress and prosperity became evident. But the growing influence of India became an eyesore to Pakistan and China. The grave foreign exchange position has damaged the prospects of replenishing our granaries and sustaining our industrial efforts to meet our military and social needs. The embarrassment caused by stoppage of arms, shortfall in foodstuffs, foreign aid, and all other difficulties can be tided over with the firm determination to live to achieve the objective. The determination to be self-reliant will enthuse every patriotic citizen to contribute his mite to the reconstruction of ebullient India. The common man has offered his services. Engineers have also played a good role and there is a very good opportunity for our fraternity to do its best in tiding over the present crisis.

Electrical power and industrial growth

Among the various available energy sources, electricity constitutes as an advanced form of energy. It not only acts as prime mover but also provides a multiplier effect in the production and social processes. Due to high efficiency and easier handling, the electric power is constantly replacing other forms of energy. It is estimated that while the gross national products grow at the rate of 3-4% annually, electricity consumption doubles itself in ten years. The statistics show that (1) the rate of growth of electric power production tends to move ahead of the other factors of production in an industrial economy, and (2) electrical power development is a prime factor rather than an anticipatory outcome of a developed economy. All the nations are alive to the contribution of electric power and are engaged in its substantial development.

I believe that the status of electric power development in the industrial economy is identical to the value and significance of fertilizers and irrigation in the agricultural economy. In the countries where agricultural orientation is an economic compulsion, the utilization spectrum of electric power increases manyfold and its end-uses become multifarious. A source of electric power gives rise to newer activities thereby resulting in further demand which, in turn, again leads to fresher impetus to economic activities. An example of the operation of the 'multiplier effect', is the ever growing industrial development of Bombay City and its never quenching thirst for electric power. With the development of electro-metallurgical and electrochemical industries as well as other power-intensive industries, the comparative cost consideration are likely to draw such industries to those countries which offer cheaper electric power with stable business conditions.

The National Council of Applied Economic Research, New Delhi has projected an estimate of the total effective consumption of electricity between 1955 and 1975 in India; yet the power shortage continued to remain acute. A revised assessment of power requirements in the light of anticipated industrial growth was necessary and a committee of experts has submitted its findings to the Government of India.

Power development in India

The pattern of power development in the country is governed by the provisions of Electricity Supply Act, 1948, under which electricity boards have been constituted in each state for the purpose of generation and distribution of electricity within the States. The boards are more or less government controlled, and hence the initiative for power schemes rests with the government. The new power development plans are guided by considerations of (1) the capital cost per kW of installed capacity, (2) the foreign exchange component, (3) the cost per kW generated, (4) the duration of project construction, and (5) its impact on allied activities. The average cost of electricity for hydro, coal fired and diesel power stations are considered to be in the neighbourhood of 2-3, 3-5 and 20-25 paise per kWh, respectively. The cost of atomic power generation is estimated at 3.5 to 4 paise. The Government prefers hydro-schemes because they require less foreign exchange for these, and also because there is no fuel element.

The electric power generation in the country has failed to keep pace with the industrial and social growth. It appears that massive efforts are needed to boost power production, and to do so, the participation of private sector is desirable. Power generation industry in most parts of the world is a joint venture between the private and the public sectors. The industry would certainly receive new impetus if the private participation is encouraged.

Rural electrification

Transmission and utilization of electric energy in rural areas is an intricate problem all over the world and is of significant importance to developing countries of Asia where the demographic composition is predominantly rural. In India, it is expected that by 1966, about 52,000 villages will be electrified. The current rural electrification programme is mainly oriented towards social amelioration efforts such as street and domestic lightings. The electricity is also being used for agricultural pumping. It will be economical, if the electric power is received from a centralized system and its distribution is entrusted to the co-operatives or the municipalities or *zila parishads*.

Technology in power development

A slight decrease in construction cost or a slight increase in efficiency of generation is likely to mean considerable savings. It should therefore be considered how best the recent advances in power technology can be adapted. Among the notable developments are those relating to super critical pressures for steam turbine generators, extra-high voltage transmission, power pooling and integration of power systems, nuclear power stations, load despatch, computer control, etc.

There is a general inclination to concentrate power generation capacity in a few large stations, because of economic advantages. It is noted that a relative increase of 10% in thermal efficiency between 30 MW and 200 MW would result in reduction in coal consumption of about 33%. The power plants in India have taken advantage of these developments and the installation of increased size turbo-alternators has resulted savings in coal consumption; although larger content of foreign exchange expenses is involved in installing high power units.

An important problem in India is of reaching power economically to end-users. According to Energy Survey of India Committee, investment in transmission can save very considerably the investment in generation. It is seen that transmission of power is cheaper than transport of coal, and hence it is desirable to set up large thermal power stations in the vicinity of coal fields. It has now become necessary for India to plan power programme on a regional basis and to operate power systems of neighbouring electricity boards as an integrated pool.

Electrical equipment industry

The indigenous manufacture of major electrical items have been instrumental in creating a situation in which the country in near future may gradually be able to overcome the impediment of foreign exchange. The operations of heavy electrical complex at Bhopal, has created a much desired potential for electrical equipment. The Government of India plans to have a heavy electricals plant at Ranipur, U.P., to manufacture hydraulic turbines and generators and D.C. motors of large horse power. The other plants are being set up at Ramachandrapuram in Andhra Pradesh and a High Pressure Boiler Plant at Tiruchi in Madras. ACC-Vicker-Babcox Limited will also be producing boilers. Thus a nucleus for heavy electrical manufacture has been established. The overall industrial picture in the electrical equipment field appears to be satisfactory. Although, many of the units in the public and private sectors have been short of full production mainly because of shortage of raw materials. There is limited possibility of any improvement in the situation due to foreign exchange shortage, and diversion of resources towards defence efforts.

Electric power in Maharashtra

The origin of electric power in Maharashtra is traced to a 4000 kW power house built at Wadi Bunder in Bombay in 1907. Since then the power production in the State has rapidly grown mainly due to Tata-Koyna-Railway-Nasik and Khaparkheda-Paras-Bhusawal systems. Of the total power production in the State, the Maharashtra State Electricity Board commands a total effective production of 442 MW. The power position in Tata-Koyna system indicates that the critical power shortage is likely to be felt in 1967-68, 1968-69 and 1969-70 when the anticipated deficits are likely to be 318 MW, 271 MW and 289 MW respectively. The position of Khaparkheda-Paras-Bhusawal system, however, indicates a surplus of 159 MW at the end of Fourth Plan. It appears that the high demand centres for electric power, viz., Bombay-Poona industrial zone would continue to have shortfall for many years to come. A committee of experts may be appointed to determine how best the power requirements of this zone can be met to the full. However, a possible course of action appears to be the establishment of a super thermal power station in the Bombay-Poona industrial zone.

The power position in the State outside of industrial zone is none-too-happy, but after the completion of projects in progress the areas may reach the satisfactory point. In the field of rural electrification, the State had, at the end of financial year 1963-64 electrified 2,372 villages and had supplied electricity to 16,724 agricultural pumps. The rural electrification has become very necessary for increased agricultural production. In Maharashtra in spite of the lack of encouragement, the textile industry, small scale industries and many other industries had progressed before the dawn of independence. The private enterprise was responsible for such a progress.

As the result of planning, the public sector was set up to supplement the private sector, and this accelerated the tempo of production. Due to rapid growth of industries in the private sector and the cooperative sector, Maharashtra has attained a very high place among highly industrialised states in India'.

Summaries of Papers Published in the Journal, vol. 46, no. 8, pt. EL 4 and HI 2, April 1966

ELECTRICAL ENGINEERING DIVISION

The Derivation of Transients of a Saturated Synchronous Machine Equipped with Voltage Regulators

P. K. Mukherjee

Non-member

This paper derives the transients of a synchronous machine equipped with two types of voltage regulators, *i.e.*, the type which operates on the field circuit resistance and the type which employs amplidynes or magnetic amplifiers, approximating the operating part of the open-circuit characteristic to a tangential line. The result of a few tests, done to verify the theoretical deductions, are also given.

A Generalised Theory of Protective Relays and Its Application to Distance Protection—1 : Theory

Dr. S. P. Patra

Associate Member

and

S. R. Bandyopadhyay

Non-member

This part of the paper enunciates a generalized theory underlying the operation of protective relays. It shows that the basic principle of relay operation is the comparison of two electrical vector quantities on the basis of either their amplitudes or their phase differences. The technique of deriving these quantities from the power system in order to achieve a particular relay characteristic has been indicated. Both the methods of comparison can be interchangeably used to produce, on a complex plane, any circular characteristic of protective relay.

Measurement of Synchronous Machine Power Angle

S. M. Peeran
Non-member
and
B. L. Mathur
Non-member

The measurement of synchronous machine 'power angle' (also known as the 'rotor angle') under steady state and transient conditions is necessary for stability studies. A direct reading power angle meter is a useful guide to power station operators as well as to investigators of the stability problem in synchronous machines. This paper suggests simple methods of measuring the power angle, which can be readily adopted for the existing machines in power stations. Two of the methods suggested do not resort to the use of a tacho-generator. A brief review of the existing work in this field is also given.

Solution of the Problem of Peak Demand in the Southern Regional Grid

S. A. Quader
Member

One of the major problems the Southern Regional Board has to cope up with is the provision of sufficient capacity for peak demands. The demand for power in the Region is increasing in geometric progression, doubling every five years. To meet this phenomenal increase, steps have already been taken to instal larger generating units, both hydro and thermal including nuclear, and to form power pools; but the problem of peak provision is still to be solved in an adequate manner. This paper proposes a suitable method for the solution of the problem.

Lightning Protection of Directly Connected Rotating Machines

N. Rama Rao
Non-member
and
B. V. Dutt
Non-member

Lightning protection of rotating machines has been investigated in the past. The case of rotating machines connected with overhead lines through transformers has been studied in considerable detail. This paper deals with some particular aspects of the lightning protection of rotating machines connected directly with overhead lines, which have not been dealt in sufficient detail in the available literature. It is well known that the basic scheme of lightning protection of rotating machines involves line arrester, lines inductance or a reactor; a capacitor across the machine and a machine arrester. It also presents the results of the surge voltage build-up across the machine terminals under different conditions and prescribes the minimum distance necessary between the machine and the line arrester for various ground resistances taking into account the arrester discharge voltage characteristics and other factors.

Temperature-Rise in Stator Winding of a Three-phase Induction Motor Connected with Unsymmetrical Supply

Dr. Ing. N. N. Roy

Associate Member

One of the basic factors which are taken into consideration in the design of an electrical machine is the probable temperature rise in the windings. In the case of an induction motor, a knowledge of the temperature rise of stator winding is essential. The temperature rise in stator winding of an induction motor can be generally known from the data supplied by the manufacturer for a particular condition when the motor is connected to a normal symmetrical supply system. However, experience indicates that due to inevitable non-uniform distribution of single-phase loads, most power systems become unsymmetrical. The temperature rise of stator windings of a three-phase induction motor connected with an unsymmetrical supply system becomes excessive. It is not possible to find out the abnormal temperature rise likely to occur in the stator windings under such unsymmetrical conditions from the data supplied by the manufacturer. This paper proposes a method of computing and thus predicting the possible temperature rise in the stator windings of a three-phase induction motor connected with unsymmetrical supply. The temperature rise has been calculated by the proposed method for a number of motors under different degrees of asymmetry in the supply voltage. The results so computed have been verified by actual measurement of the temperature rise in the same machines under similar conditions by the rise-in-resistance method. A close agreement has been obtained between the calculated and the measured values.

A Circuit for the Synthetic Testing of Vacuum Circuit Breaker—1: the Main Circuit

D. G. Tamaskar

Associate Member

Direct testing of circuit-breakers requires a large MVA capacity of test plant, the size of which depends on the interrupting capacity of the circuit-breaker to be tested. This paper shows that it is possible by a proper coordination of two independent circuits, a current circuit and a voltage circuit, to simulate the conditions of a direct test on a vacuum circuit-breaker, involving a total plant capacity which is only a fraction of the rupturing capacity of the circuit-breaker under test.

HINDI SECTION

Computer and Human Power

K. M. Agrahari
Non-member

To save human power and time the scientist and technologist has not only invented machines to replace manual work but also machines to replace brain power. Calculating machines have now been invented which solve complicated equations in a few hours. a result which could not be achieved by manual operations. This paper briefly describes a few such machines and principles of their working.

Problem of Drinking Water in Villages of Uttar Pradesh

O. P. Bishnoi
Member

The problem of drinking water in villages of India has so far remained neglected. This paper throws some light on this problem in the villages of Uttar Pradesh. Scarcity of drinking water in 27,000 villages of this State not only causes hardship to the population, but also endangers their health. The situation is rather serious in the hilly regions, and in the arid and stony tracts in the western and southern parts of the State. A recent survey has revealed that about Rs. 100 crores will be required to relieve the distress of about 15 million peoples of these villages. Unless necessary steps are immediately taken on a planned basis to solve this problem, it will become impossible in future due to continuing rise in prices of labour and materials to relieve thhe distress of the peoples and this will result in a loss of health and precious lives.

Use of Sewage for Increasing Production from Land

O. P. Bishnoi
Member

The paper briefly describes how sewage can be utilized to increase the yield of crops, and compares its advantages and disadvantages in comparison with chemical fertilizers, the latter being in short supply in the country. Methods of purification of sewage have been explained. Its use has also been suggested for pisciculture, *viz*., rearing of fish in ponds. Finally, precautions have been recommended to avoid danger to health from use of sewage.

Study of Steel by the Electron Microscope

Dr. G. P. Chatterjee
Member

Electron microscope is a multipurpose instrument recently invented. It can examine even a micron part of metals, alloys and minerals. This instrument has been installed for the first time in India in the Research and Control

Laboratory of the Durgapur Steel Works. Information that has been collected through the instrument was impossible otherwise. This instrument is specially fine and delicate, and great care was exercised during its calibration. This paper describes its method of working and gives details of some of the researches made in the laboratory by using it.

Navbharat Sine-Cosine Tables

Maj. N. B. Gadre

Member

The author in this paper describes how he has rediscovered two different non-calculus methods for an extremely accurate determination of sine-cosine values upto hundred or thousand digits with accuracy while the existing tables hardly go upto 21 digits.

Houses of Foam Plastic

Prof. M. R. Mehta

Non-member

This short paper describes a revolutionary method of building houses in West Germany with a material called 'Osofoam'. Formerly this material was used only as a non-conductor, but now it is being used for building houses which can resist and bear the effects of changing temperatures, winds, earthquakes, etc., as strongly as stone, steel and concrete. The method of building such houses is briefly mentioned.

THE PRESIDENT VISITS THE LOCAL CENTRES

Andhra Pradesh Centre

On February 11, 1966, the President, Shri B. P. Kapadia arrived at the airport and was received by Lt.-Col. R. S. Attre, the Chairman of the Andhra Pradesh Centre, Shri Dildar Husain, Past-President and Honorary Life Member of the Institution, Shri J. R. Jussawalla, the oldest member of the Institution from the Centre, Shri O. Thimmaiah, Shri N. Subba Rao, the Honorary Secretary of the Centre, Shri R. M. Patri, Shri Krishna Rao Naram, Shri Vidyasagar and others of the Centre.

The same evening the President met the senior members of the Centre at the Secunderabad Boat Club and held informal discussions with them.

On February 12, 1966, the President attended the dinner given in honour of his visit by the members of the Local Committee and senior members the Centre.

On February 14, 1966, the President visited the Institution building at Khairatabad. He was taken round the site of the island where the statue of Sir M. Visvesvaraya is to be erected in the near future. In the evening, the President addressed the Students in a meeting held under the Chairmanship of Lt.-Col. R. S. Attre. A report of activities of the Students Chapter was read by the Joint Secretary, Shri P. G. K. Murthy. A vote of thanks was proposed by Shri R. Satyamurthy, Chairman, Students Chapter.

The President left Hyderabad on February 15, 1966.

A few photographs taken on this occasion are displayed below.

SHRI B. P. KAPADIA, PRESIDENT, WITH LOCAL CENTRE COMMITTEE MEMBERS AND SENIOR MEMBERS OF ANDHRA PRADESH CENTRE

SHRI B. P. KAPADIA LISTENING TO LT.-COL. R. S. ATTRE (*standing*), CHAIRMAN, ANDHRA PRADESH CENTRE

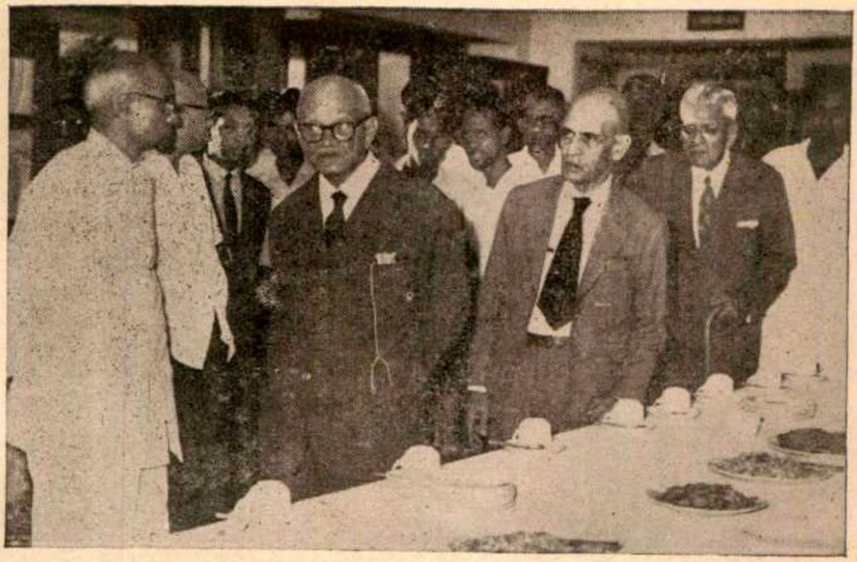
INSTITUTION OF ENGINEERS (INDIA)
INSTITUTION OF ENGINEERS (INDIA)

SHRI B. P. KAPADIA AT THE PHOTO GALLERY OF CHAIRMEN AND HONORARY SECRETARIES OF ANDHRA PRADESH CENTRE

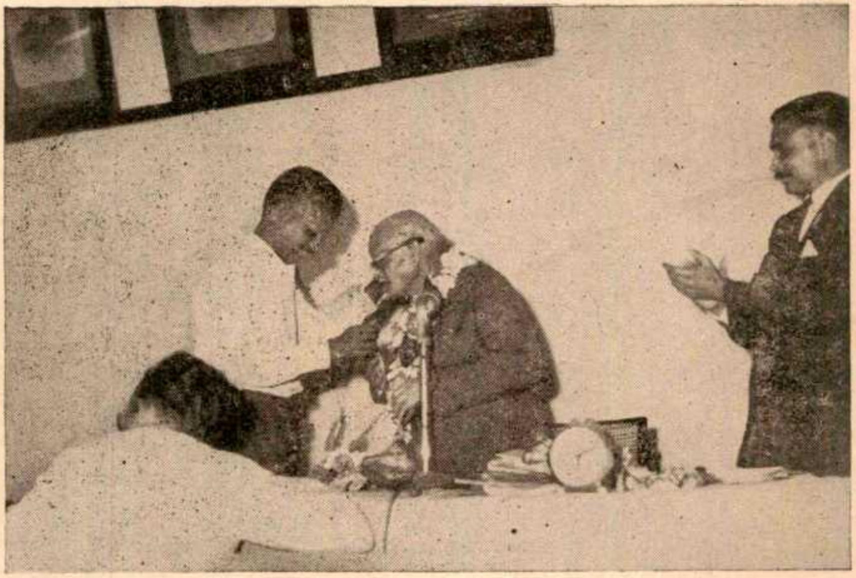
LT.-COL. R. S. ATTRE, CHAIRMAN, ANDHRA PRADESH CENTRE, WELCOMING THE PRESIDENT

Shri Kapadia, President, Addressing the Meeting of Andhra Pradesh Centre

President with Shri Dildar Husain and Shri J. R. Jussawalla



President with Senior Members and Students of Andhra Pradesh Centre



President Being Garlanded by Shri A. G. K. Murthy, Honorary Secretary of Students Chapter, Andhra Pradesh Centre

Shri P. G. K. Murthy, Joint Honorary Secretary, Students Chapter, Reading the Report of the Chapter

Shri Kapadia and Lt.-Col. Attre with the Committee Members of Students Chapter

THE PRESIDENT WITH STUDENT MEMBERS

THE PRESIDENT WITH SENIOR MEMBERS AND STUDENTS

Bengal Centre

A general meeting of the Student Members of the Bengal Centre was held at 6.30 p.m. on Tuesday, February 8, 1966, in the Sir R. N. Mookerjee Hall of the Institution at 8 Gokhale Road, Calcutta, under the Chairmanship of Shri T. P. Marik. The President addressed the gathering.

Shri K. C. Banerjee, M.I.E., Chairman of the Students' Welfare Sub-Committee, and some Corporate Members also addressed the gathering.

Eight Students took part in the deliberations and placed their grievances before the President, who assured them of his due consideration.

Shri K. C. Banerjee, M.I.E., offered a vote of thanks to the President, which was carried with acclamation.

Bihar Centre

Immediately after the conclusion of the 46th Annual Convention held at Patna the President Shri B. P. Kapadia paid an official visit to the Bihar Centre of the Institution. He met the various engineers, who helped in the successful organization of the 46th Annual Convention at a tea party arranged by the Centre.

The President addressed the local student members at the Institution at 5.15 p.m. on February 5, 1966, when he invited them to let him know their difficulties, if any. A few students spoke, and it was decided that they should send a copy of the proceedings of their meeting to him for necessary action. The meeting closed with a vote of thanks to the President.

Madras Centre

As reported earlier in the *Bulletin* for March 1966, the President visited the Madras Centre of the Institution on February 9-10, 1966.

B. SESHADRI*—AN ACCOUNT OF HIS CAREER

Dildar Husain

Past-President and Honorary Life Member

Early life and education

Born in 1918, Mr. Seshadri was educated in the Government Model High School, Saidapet, and the Presidency College, Madras. He took his B.Sc. degree in Physics from Madras University in 1937 standing in the first class.

He received his engineering education at the Indian Institute of Science, Bangalore, obtaining the Certificate of Proficiency in Electrical Technology in 1940, and thereafter commenced his employment career as a Research Assistant in the Department of Electrical Technology in that year. In 1943,

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*Mr. B. Seshadri, M.I.E., the Secretary of the Institution of Engineers (India), retired on December 31, 1965.

B. Seshadri
SECRETARY 1957-65

he obtained his Associateship of the Indian Institute of Science for his thesis 'Studies on Flat Surfaces'.

Early employment career

He joined Associated Electrical Industries (India) Ltd., at its Madras Office in 1944 as Assistant Commercial Engineer, and handled the firm's contracts with the Madras Government Electricity Department for the Mettur, Vizagapatam and Bezwada power stations, besides other work. In 1945, he left the firm and proceeded to the United Kingdom.

Education abroad

He was on the staff of the National Physical Laboratory, U.K., for a year, and in 1946 joined the City and Guilds College of the Imperial College of Science and Technology, South Kensington, for the post-graduate research under Professor Sir Willis Jackson, F.R.S. He was awarded the Diploma of the Imperial College in 1949, and also obtained the M.Sc. (Eng.) degree from London University for his thesis, 'Some Properties of Ferromagnetic Materials at Centimetre Wavelengths'.

Joins the Institution

On his return to India, he joined The Institution of Engineers (India) as Assistant Secretary (Technical) in 1950. For the first year, he was attached to the Central Board of Irrigation and Power in Simla and in New Delhi, in connection with the preparations and arrangements for the four international engineering conferences which were later held in New Delhi in January 1951, including the Eleventh Sectional Meeting of the World Power Conference. In March 1952, he joined the Headquarters Office of the Institution in Calcutta.

Secretary of the Institution

In 1955 he was made Additional Secretary, and in November 1957, he was appointed Secretary of the Institution. Before taking over as Secretary. he and the then President Mr. Kanwar Sain, attended on behalf of the Indian National Committee, the Sectional Meeting of the World Power Conference in Belgrade, Yugoslavia. Mr. Seshadri also visited the national engineering societies in the United Kingdom, Australia, West Germany, the Netherlands, Belgium, and France and established for the first time contacts with the continental national societies in Europe which were later to develop into reciprocal relations.

In 1958, Mr. Seshadri, with the then President, Mr. D. P. R. Cassad, attended the Fourth Conference of Engineering Institutions of the British Commonwealth in Australia and in New Zeland. In the following year, 1959, he visited Ceylon with Mr. Cassad and a party of Indian engineers, at the invitation of The Institution of Engineers (Ceylon), to inspect engineering projects in that country. In 1962, he visited the national engineering societies of the United States in New York, and later attended, with the then President, Major-General Harkirat Singh, the Sixth Conference of Engineering Institutions of the British Commonwealth in Canada.

PROF. N. S. GOVINDA RAO, PRESIDENT 1965-66, WITH SHRI B. SESHADRI, THE RETIRING SECRETARY

Leaves the Institution

When Mr. Seshadri returned to India, perhaps little was he aware that he would return back just 14 short years later. From a position of prominence and influence, he leaves the Institution but not before he has influenced and contributed so much to the professional and intellectual development of the organization, of which he held the administrative reins, in several ways. The orientation conceived by him breaking the traditional, stagnant pattern of administration, earned for the Institution a pre-eminent place not only in the country but among the other professional societies outside it as well.

Some traits of his character

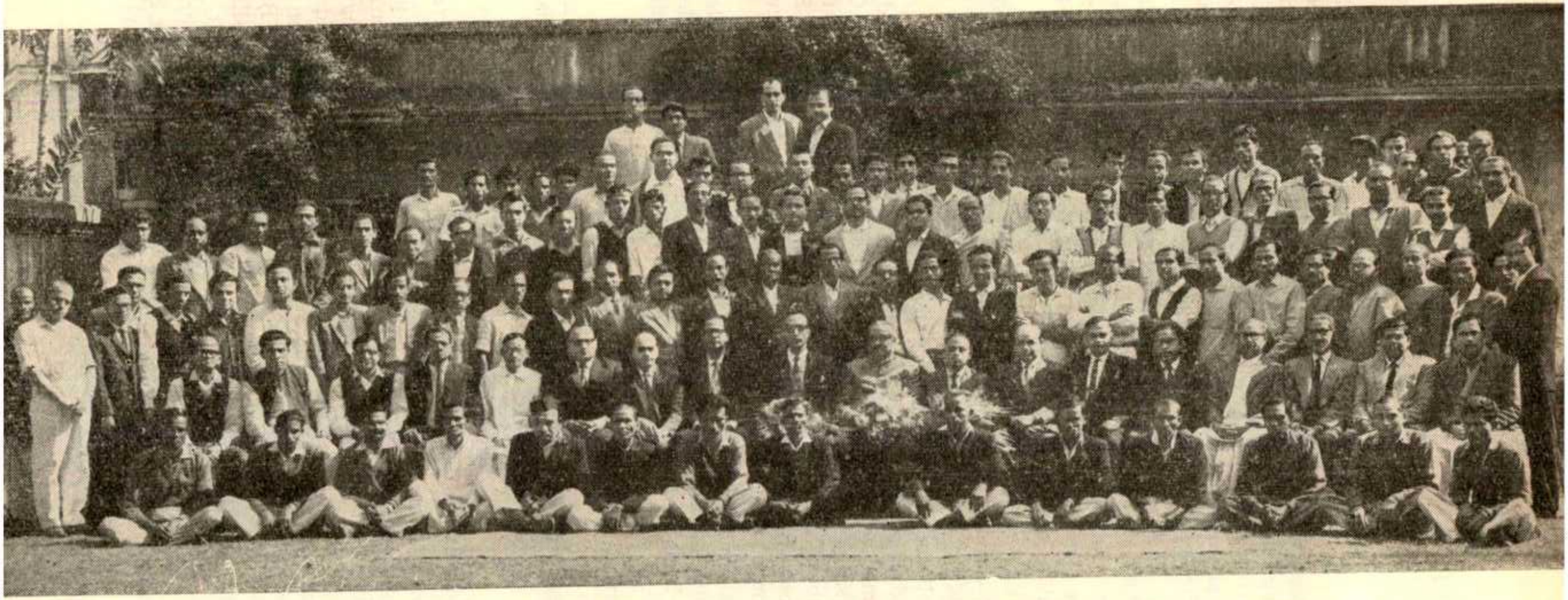
His simplicity, gentleness and wisdom together formed a force that was to elevate the condition and character of the great body of men who worked for him. He deprecated distinction which kept away all but the previleged from acquiring the worthwhile needs of life. He recognized the differing abilities of individuals but he felt that each had a right to raise himself by his efforts in a free competition of talents. It was he who set to liberalise the strict Calvinistic belief of at least some that beyond the knowledge they received from their sense, there was more for them to gather by faith and hard work.

Through scholarship, deep understanding and penetrating observation were evident in whatever he did or wrote—be it on education, travel, language, print, or wild life. He spoke the common language, but voicing progressive ideas and ideals. His devotion for the Institution over-shadowed his personal works.

Although he had exceptional ability in the organization of ideas for presentation, be it at a Council Meeting or on a public platform, before a large gathering, he spoke little—for him silence was golden. He was always composed and familiar and at his best with ideas and information. Possibly many cannot say for certain what effect this tall but gentle-scholar with his dedicated purpose had upon his audience. He was convinced that his duty toward the cause of the Institution's growth lay in how the public and professional interest were aroused in that cause. Consequently, he planned and translated his ideas into print, many of which have now occupied favoured position in the much referred columns of other professional societies.

His influence on men, extended beyond the borders of the Institution; his most important achievement however was the way he influenced men with a philosophy all his own: 'thought and feeling should alter to suit new activities without loss of identity with older values and conditions'. Although he spent much of his time keeping up with the growth of his organization, he still found time for recreation, travel, photography, wild-life and reading. He will be recognized by the personal services he rendered to the profession and by his untiring and devoted efforts to made the Institution a place to rely upon and work with in the welfare of the community.

Mr. Seshadri has left for settling permanently in Canada.



HEADQUARTERS STAFF WITH PROF. N. S. GOVINDA RAO (PRESIDENT 1965-66) AND SHRI B. SESHADRI.
THE RETIRING SECRETARY

Other points of fact

Mr. Seshadri joined the Institution as Associate Member in 1953 and was transferred to full membership in 1956. He was the Editor of the *Journal* and the *Bulletin* of the Institution till his retirement on December 31, 1965. He was the Editor of the 'Transactions of the Eleventh Sectional Meeting of the World Power Conference' published in 4 volumes. He was also the Editor of the reprinting of the volume entitled 'General Sir Arthur Cotton—His Life and Work' reprinted by the Institution. Limitations of space will not allow the mention of multifarious other publications of the Institution of which Mr. Seshadri was also the Editor.

He was the Secretary, Indian National Committee, World Power Conference, from 1953 till his retirement in December 1965. Also, he was the Secretary, Indian National Committee, World Petroleum Congress, and the Secretary of the National Member Organization of the International Federation of Automatic Control.

He was author of over two hundred articles on engineering subjects, natural history, and travel in journals, magazines and newspapers in India, the United Kingdom and elsewhere.

He was well-known for his work for wild life conservation in India and was reputed as a writer and photographer on wild life. He had photographed and filmed wild life in Australia, Ceylon, United States and Canada. He has been writing a book on Indian Wild Life proposed to be published by Faber & Faber, London. He was Member, Fauna Preservation Society, London; Member, Bombay Natural History Society; and Member, Wild Life Preservation Society of India.

Being an all-round sportsman he played tennis, cricket, table-tennis and billiards with distinction, including the winning of many table-tennis tournaments in India and England. His other interests were sketching and music.

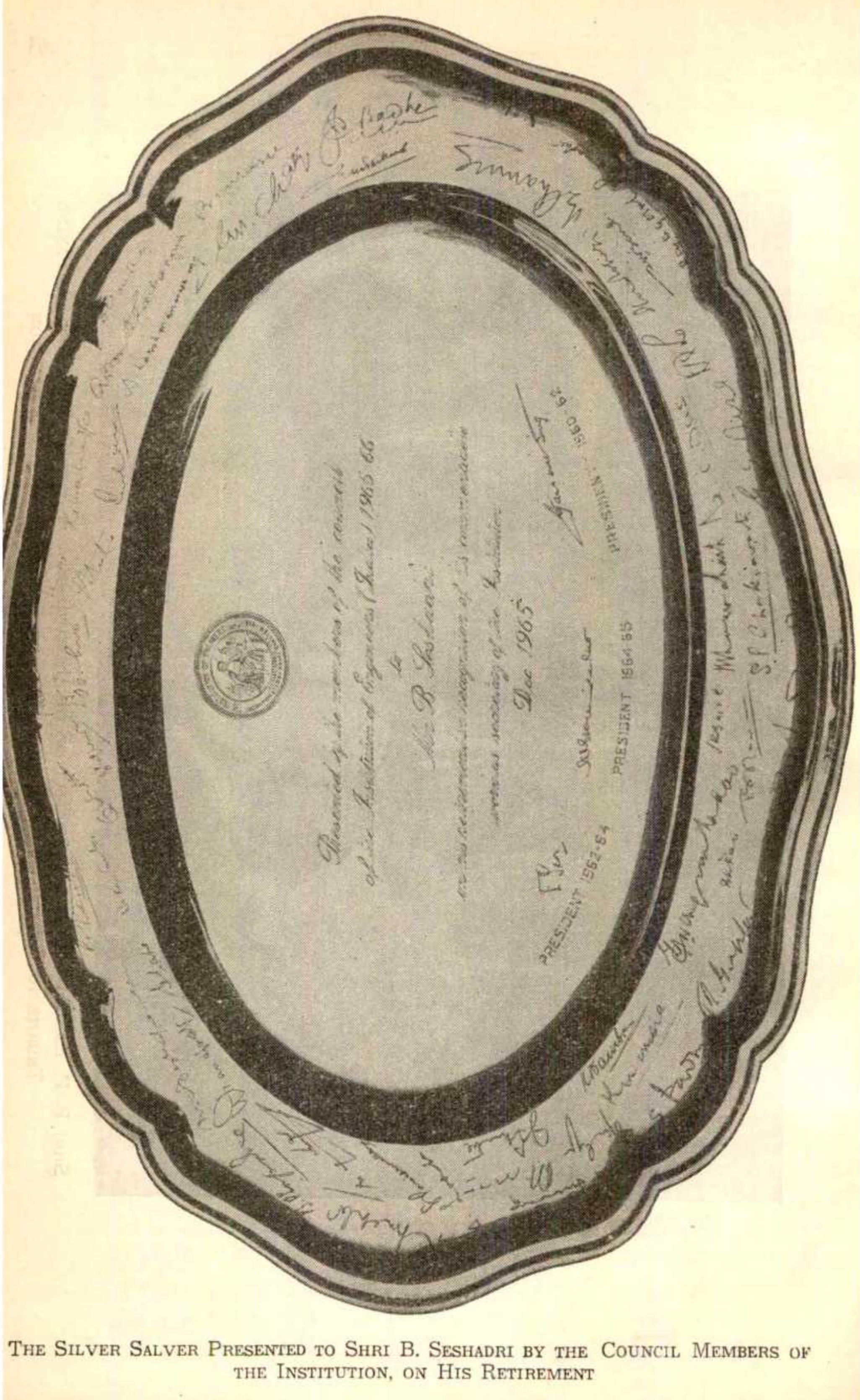
He was married to Grace Florence Peters in 1948, an American, writer, artist and well known as a child educationist during her years in India. They are blessed with two boys who are being educated in Canada.

INSTITUTION NEWS

Presentation of Silver Salver to Shri B. Seshadri, the Retiring Secretary

Shri B. Seshadri, the retiring Secretary of the Institution was given a farewell at Bombay on January 6, 1966. An informal dinner was arranged at Ripon Club, Bombay, on this occasion when a silver salver bearing signatures of the members of the Council was presented to Shri Seshadri as a souvenir from the Council members of the Institution in recognition of his valuable services to the Institution. The following members from Bombay were present on the occasion: Shri B. P. Kapadia, the President-Elect of the Institution for the Session 1966-67, Shri K. F. Antia, Shri D. R. Bhise, Shri J. G. Bodhe, Prof. P. W. Dharap, Shri V. Y. Kamat, Shri S. G. Laud, Shri F. D. Mehta, Shri E. A. Nadirshah (Past-President), Shri K. C. Pandya, Shri P. G. Patankar, Shri N. N. Purandare, Maj. R. P. E. Vazifdar, and Shri M. N. Wagle.

Shri B. P. Kapadia, the President-Elect of the Institution for the Session 1966-67, Paying Tribute to Shri B. Seshadri, the Retiring Secretary of the Institution

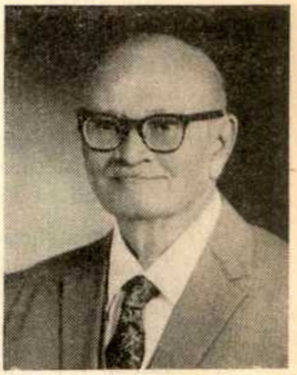


THE SILVER SALVER PRESENTED TO SHRI B. SESHADRI BY THE COUNCIL MEMBERS OF THE INSTITUTION, ON HIS RETIREMENT

Shri Seshadri thanked the Institution for this gesture. In the end Shri D. R. Bhise the then Chairman of the Bombay Centre, and Member of the Council, thanked all the members present and wished Shri Seshadri a very prosperous and happy future.

Glowing tributes were paid to Shri Seshadri by Shri B. P. Kapadia, the President-Elect, Shri E. A. Nadirshah, Past-President, and Shri J. G. Bodhe, Council member.

The President's Itinerary



Arriving at New Delhi from Bombay on March 7, 1966, Shri B. P. Kapadia, President, conferred with Dr. K. L. Rao, the Union Minister for Irrigation and Power, and also met Sarvashri S. G. Barve and Modawal. The next day, he attended the Civil Engineering Division Council Meeting of the Indian Standards Institution at 10.00 a.m., and in the afternoon, took part in the I.S.I. Annual Council Meeting.

Leaving Delhi by train on 8th evening, Shri Kapadia arrived at Jabalpur on March 9, 1966. The next day, he spent in meeting the Student members and in attending the Annual General Meeting of the Madhya Pradesh Centre. The President left for Bombay on the 11th.

Shri Kapadia stayed in Calcutta from March 25-30. Besides attending to the works of the Headquarters, he convened a meeting of the Headquarters Building Committee on March 28. The Bengal Centre gave a reception to the President on the 29th.

Shri Kapadia left for Bombay on the 30th.

LOCAL CENTRE ACTIVITIES

Mysore Centre

At the suggestion of Shri S. Nijalingappa, Chief Minister of Mysore, a study of the problem of constructing cheap primary schools for rural areas was taken up by the Mysore Centre.

A Seminar was organized in this regard on December 14 and 15, 1965, concurrent to the 9th Indian Standards Convention held in Bangalore on these days. Maj-Gen. Harkirat Singh, Adviser (Construction), Planning Commission, presided over the Seminar and many leading engineers all over the country participated in it. The highlights of the discussion were :

1. Question was raised whether the buildings for the primary schools were to be of a temporary nature or of a permanent type.
2. There were differing opinions about the use of conventional materials and prefabricated structures.
3. Preplanning and mass production of the structural members were expressed as desirable.

4. Most of the participants expressed themselves in favour of providing for modern type of schools with all amenities and study aids.
5. Cheap constructions were in general discouraged from points of safety of the children, and heavy cost of maintenance.

In the light of the above discussions, the following recommendations were made:

(i) An Advisory Committee be formed consisting of an educationist, architect, engineer, builder and the financial advisor, to discuss and plan for suitable types of schools to be constructed for the various regions suited to the climatic conditions of the regions. On a long range basis to meet the requirements of, about 10 to 15 years, say, a regionwise programme of construction of schools be prepared.

(ii) The Advisory Committee should draw up the standards of space and amenities to be provided for the schools.

(iii) The components of school structures should be standardised, and manufactured on mass scale to cover the requirements for a period of about 15 years.

(iv) The construction of buildings for the schools may be either of the conventional materials of construction, or prefabricated concrete and steel structures, although the latter are preferable in view of the cost of production.

(v) Cheap constructions may be avoided to prevent accidents and extensive maintenance.

(vi) The programme of construction and expansion of schools may be phased according to the availability of finance.

(vii) In places of over crowding for lack of accommodation, the classes may be held in shifts so that economy is achieved in outlay on construction.

(viii) A training programme may be arranged for the construction of such schools for the artisans so that the period of construction is limited to the standards fixed by the Committee.

INSTITUTION NOTICES

DEPOSIT OF SUBSCRIPTION IN THE STATE BANK OF INDIA WITH CARDS A & B

Everyday the Headquarters is receiving a large number of card A from Students with request to acknowledge their payments. For the information of all concerned it is notified that the Card A should be retained with members as a proof of the deposit made by them in the Bank.

Illustrious Profiles

At the 439th meeting of the Council held in Lucknow in February 1965, Prof. N. S. Govinda Rao, Past-President, proposed that a committee should be formed to publish biographies of eminent Indian engineers. The Council agreed to the proposal and resolved that these biographies should be restricted to engineers who are no longer living. Shri Dildar Husain, Past-President and Honorary Life Member, has taken active part in compiling these biographies and the book entitled 'Illustrious Profiles' is the result of his tireless efforts. In this book an attempt has been made to study the profiles of some of the distinguished Presidents of the Institution hailing from Uttar Pradesh in relation to their concrete environments, physical as well as social, thereby presenting the 'total situation' of these men of eminence in engineering. It is hoped that this publication will furnish a rewarding study to the students of modern engineering technology in which human engineering plays as vital a role as the disciplines which concerns themselves with engineering machines operating for human use—disciplines which govern the operation and use of technology indicated by the radar, the aircraft, the rockets, submarines, electronic computors and hundred others of a similar kind.

The book is priced at Rs. 4.00 per copy and orders should be addressed to the Assistant Secretary (Technical) in the Headquarters office.

Use of Fly Ash in Building Industry

This monograph on 'Use of Fly Ash in Building Industry' is the outcome of the approval given by the Council of the Institution at its 435th Meeting held in Bangalore on May 23, 1964, to a resolution moved by the Chairman of the Civil Engineering Division.

The contents of this monograph highlighting the features of the highly versatile building material, fly ash—an industrial waste produced in profusion in the thermal stations of India and difficult of disposal as produced—which was the subject of investigations by a research team at the Central Building Research Institute, Roorkee, was approved by the Council for publication in its present form.

The cost of the monograph is Rs. 5.00 and orders may be addressed to the Assistant Secretary (Technical) at the Headquarters office.

FORTHCOMING CONFERENCES

28th World Congress for Housing and Planning, Tokyo, May 8-14, 1966

The 28th World Congress for Housing and Planning will be held in Tokyo, Japan, from May 8 to 14, 1966. The objects of the Congress are: (i) Urban Transportation and Urban Pattern, and (ii) Housing Standards for Low and Lowest Income Groups in Relation to the National Level or Economic and Social Development. The first object includes a discussion of the evolution of transportation needs and systems in the 20th century, the influence of present urban transportations systems on the shaping of the urban pattern, and of future transportation systems as a positive factor in the realization of a well-organized urban pattern. The second object includes a discussion of the main economic and social characteristics of the low income groups covered, a description of the present housing standards for these groups and identification of deficiencies in these present standards; the expected future development of these low-income groups, and possible changes in their housing standards in the light of the expected development of the national economy, of social conditions and of physical and technical possibilities.

An International Exhibition on Urban Renewal will be opened on May 13, 1966. Several post-Congress tours will also be arranged.

Further details can be obtained from the International Federation for Housing and Planning, 43 Wassenaarseweg, The Hague, Netherlands.

IMEKO Symposium on 'Microwave Measurement', Budapest, October 12-14, 1966

The Hungarian Member Organization of IMEKO, the Scientific Society for Measurement and Automation, will organise a Symposium on 'Microwave Measurement 'in Budapest from October 12 to 14, 1966. Prospective authors wishing to contribute papers for presentation at the Symposium should forward a summary in triplicate by April 30, 1966, to the Organising Committee.

Further particulars can be obtained from the Organising Committee of the IMEKO Symposium on Microwave Measurement, P.O.B. 457, Budapest, Hungary.

Ninth Automation and Instrumentation Conference and Exhibition, Milan, November 10-25, 1966

The Ninth Automation and Instrumentation Conference and Exhibition will be held in Milan, Italy, from November 19 to 25, 1966. The Conference will be held in four Sessions: (i) Theory-automatic Control theory, switching theory, and general programing methods and theory of languages; (ii) Components, Instrumentation, Devices—electronic techniques, pneumatic and oleopneumatic devices, telemetering and telecontrol systems, and information processing systems; (iii) Applications—energy production and transmission, mechanical processes, chemical processes, thermal process and iron working processes, and (iv) The Automation and Its Economic and Organizational Impact on Management. Papers are invited on these subjects.

Further details can be obtained from FAST, Federazione Delle Associazioni Scientifiche e Techniche, P. le R. Morandi 2, Milano, Italy.

Second International Conference on the Structural Design of Asphalt Pavements, Ann Arbor, August 7-11, 1967

The Second International Conference on the Structural Design of Asphalt Pavements will be held at the University of Michigan, Ann Arbor, Michigan, U.S.A. As with the First International Conference in 1962, the Department of Civil Engineering of the U-M College of Engineering is sponsoring the 1967 Conference in cooperation with The Asphalt Institute, U.S.A., and the University Extension Service. Seven internationally known authorities on highway research and technology have been appointed session chairmen of the second Conference.

Further information can be obtained from Prof. W. S. Housel, P.O. Box 619, Ann Arbor, Michigan, U.S.A.

NAMES OF SUCCESSFUL CANDIDATES IN THE STUDENTSHIP AND ASSOCIATE MEMBERSHIP EXAMINATIONS HELD IN NOVEMBER 1965

The following candidates have been declared to have passed the Studentship and Associate Membership Examinations held in November 1965.

STUDENTSHIP EXAMINATION

Roll No.	Name of Candidate	Roll No.	Name of candidate
St. 5	D. Saxena	St. 509	K. Govinda Rajan
St. 24	G. Lewis Alexander	St. 514	G. Nethaji
St. 152	P. S. Yada	St. 544	T. S. Kannan
St. 166	Y. D. Vivrekar	St. 554	J. Prabhaker
St. 299	B. Singh	St. 555	M. K. Balasubramaniam
St. 300	S. D. Bahl	St. 556	K. Ramamurthi
St. 313	K. K. Malik	St. 575	V. Raman
St. 320	D. R. Kenkre	St. 584	B. H. Suresh Pai
St. 325	K. S. Singh	St. 604	K. C. Subbaiah
St. 348	M. L. Duggal	St. 621	P. K. Krishnan
St. 376	C. R. Rao	St. 633	N. Natarajan
St. 392	D. Kumar	St. 639	Karnail Singh
St. 407	M. B. Murty	St. 648	S. K. Kaushal
St. 463	Y. P. Thareja	St. 673	R. S. Bhide
St. 478	A. S. Chima	St. 696	K. K. H. Gulhati
St. 492	T. J. Jayashankar	St. 700	Sandip Bhattacharya
St. 499	C. Mukundan	St. 735	M. Thomaskoshy
St. 506	S. Yandi Raju	St. 769	R. V. V. R. Rao

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A

(Existing Scheme)

(Read A after each Roll No.)

Roll No.	Name of candidate	Roll No.	Name of candidate
3	Gopal Sitaram Jogalekar	114	G. Ramachandra Rao
8	Ram Swarup Rawat	115	Kadaba Aswathanarayana
10	Ram Gopal Kaushik	117	Bettada Vasudevachar
15	Jyoti Swaroop Saluja	122	D. K. Ganapathy
22	Harish Chandra Varshney	127	S. Nagaraja
45	Gunavant Bababhai Shah	135	R. Ramanathan
46	M. K. Desai	136	Naganatha Ramamoorthy
49	N. C. Sanghavi	140	V. Gopalan
63	S. K. Ayyangar Srinivasan	143	Doddavaram Narayana Rao
68	S. Muthukumarasamy	145	Baradhalwar Balaraman
69	H. S. Manjunatha	154	Brahmachari Goutaman
72	Y. K. Swarnalingam	166	A. K. Khubchand Rajwani
73	C. N. Parthasarathy	167	B. S. Tandel
80	Seshan Srinivasan	168	S. S. Mukherjee
82	M. K. Narasimhan	173	S. S. Sarode
91	A. V. Rama Murthy	176	Nanik U. Agnani
96	K. B. Singh	180	S. N. Khandelwal
108	R. Somavarma	182	Padmakar Rajaram Ketkar
109	R. N. Iyengar	194	Basudeo Sinha
113	T. P. Unni Krishnan	195	Parmanand Sinha

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
201	K. B. Mukherjee
204	Sadanand Prasad Sinha
214	Amir Ali
218	Kewal Krishan Singhi
225	Rakesh Srivastava
226	Jagat Singh Tyagi
229	Mahesh K. Rathi
230	S. N. Patil
234	Angara Venkata Rao
235	Om Parkash Nanda
237	N. C. B. K. R. Gupta
238	Hari Shanker Sharma
250	P. V. Sarma
251	S. C. Manchanda
253	R. K. Dhoble
254	M. P. Lazar
255	Gulab Singh
258	D. C. Garg
259	S. S. Choubey
260	Nand Kishore
263	Amarpal Singh
268	Manmohan Krishan
270	K. N. Vishwakarma
275	K. C. Jain
276	L. K. Murty
277	G. P. Bichpuria
279	Mahesh Chandra Airen
284	S. A. Srivastava
285	Ram Prakash
286	M. Balakrishhna Murty
288	T. V. S. S. Sankararao
291	Tara Singh
297	Sudershan Lal Bajaj
301	C. Lakshman Rao
304	V. S. Kulkarni
305	V. S. Sastry
306	J. K. Sama
309	A. Rabindranathan Nayar
310	K. N. Ramachandran
312	Namdev Shivaji Arde
313	T. S. Srinivasan
315	Pitambar Premchand Bhatia
318	Arvind Vishnu Kathavace
320	Bhalchandra Vasudeo Date
321	Mohan Purushottam Wagle
327	K. P. Paul
328	M. K. Mitra
332	Inderjit Singh Kundra
338	Shamarao Balavant Patil
351	Gustad Meherwanji Irani
356	P. J. Karkhanis
358	Dayananda Baliga
360	Chandra Prakash Saxena
366	Nitai Chandra De
371	Panambur Balakrishna Rao
374	Shashikant Pitamber Desai
381	G. K. Somnath Iyer
388	Mohindar Singh
390	M. D. Shroff
394	K. P. S. Unni
396	Ramaswami Sankaran
400	N. P. Raisinghani
401	Ramesh Shankar Pradhan
404	John Francis Pharel
409	Arvind Manilal Parekh
423	V. S. Amarnath
424	Narayanaswamy Srinivasan
425	N. K. Makhijani
432	Gobinda Chandra Mondal
434	S. R. Bandopadhyaya
440	Surya Kumar Thakkar
446	Susanta Sarkar
458	Dilip Kumar Bhattacharjee
461	Subrata Basu
463	Mihir Kanti Acharyya
473	Satyabrata Dass
486	Tridibesh Sarkar
492	D. K. Dey
494	Anil Kumar Banerjee
499	Susil Kumar Basu
504	Sasankasekhar Dasgupta
505	Priyabrata Neogi
506	Subir Kumar Basu Thakur
507	Kalyan Brata Roy
510	Biswanath Ray
513	Biswanath Mukherjee
515	P. P. Varghese
520	Prosanto Kumar Sinha
523	Naru Gopal Mukhopadhyay
524	Manindra Kumar Bhadra
525	S. K. Datta
527	P. V. Parthasarathy
539	Ramendra Narayan Deb
545	Hari Bhusan Dutta
547	Sakti Kumar Ghosh
548	Subir Kumar Majumder
550	Shyamal Kanta Pramanik
554	Reboti Ranjan Roy
555	Samir Kumar Goswami
560	Rathindra Nath Ghoshal
561	Premamoy Sen Gupta
562	Chinmoy Dutt Choudhuri

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
568	Sanat Kumar Sen
580	Amal Kanti Sarker
606	Ramapati Sengupta
607	Nikhil Kumar Banerjee
609	Jahar Lal Ganguli
619	S. Mitra
622	Dinabandhu Sirker
625	Jagat Bandhu Das
626	Chittaranjan Majee
627	Santi Ranjan Biswas
631	Ajit Kumar Bhattacharyya
634	U. K. Sinha
637	Ajit Kumar Mohalanobis
639	Sunil Kumar Roy
641	Shyamal Kumar Ghosh
647	Samar Sen
649	H. Tapadar
655	T. V. Venugopalan
656	H. K. Chatterjee
659	Krishan Chand
662	Avtar Krishan Anand
665	Manohar Lal Punyani
668	Rajinder Singh
669	Ved Parkash Dhiman
672	Kabuljit Singh Thandi
675	Bhupinder Singh
696	D. Singh
697	S. Narayan
700	Bal Krishan Soni
701	Sham Lal Khanna
705	R. K. Sharma
706	Nand Singh
707	Mohan Lal Mehra
708	Gian Singh
710	Jagadish Chandra Katyal
711	Mohinder Singh Sandhu
713	Ram Murti Sharma
719	M. P. Chacko
726	P. K. Chakrabarty
730	Chander Parkash Taneja
732	Jagmohan Singh
734	G. Ramalingam
743	Tirlochan Singh
748	R. H. Teckchandani
752	Jaswant Rai Balauja
755	Rajinder Singh Sethi
759	Harjit Singh
763	Jainti Parshad
766	Ram Lal Maiderata
769	Jyotirmoy Das
776	Rajeshwar Nath Dhawan
777	A. S. Kaneri
787	Tara Chand
793	Prem Datt Parashar
795	Vinod Puri
808	Prem Parkash Mehta
812	Gurbux Singh
813	Ram Pal Singh Panwar
824	Bhagwan Dass Bhutani
825	Krishan Lal
832	B. Channakeshva Swamy
835	Harish Chander Khaneja
848	Melu Ram Singla
852	Subhash Chander Khera
853	Bharat Bhooshan
859	Sunder Shyam
861	Sukanpal Singh Verma
873	Suresh Chandra Chaturvedi
874	Kuldip Singh Virdee
891	Jitendra Mohan Varma
898	Kailash Nath Mushran
903	Jagdish Prasad Gupta
904	Amar Singh Soni
907	Ranveer Singh Kachhwaha
908	M. Raj
916	Ram Autar Vaish
936	Narayana Sampath Kumaran
937	Siddharat Kumar Suri
939	Darshan Kumar Sharma
949	Shiam Prakash Sharma
953	Satya Paul Rawal
957	Jahar Singh Verma
965	Shyam Narayan
977	Agia Singh Saini
983	T. Banerjee
998	Kamala Kanta Supakar
999	Jagaipada Baidya
1000	Subir Kumar Ghosh
1002	Atin Kumar Bhattacharjee
1003	S. C. Das Gupta
1006	Ved Prakash
1012	K. P. Matwani
1021	Arun Kanti Ghosh
1022	R. Singh
1025	Subhas Chandra Basu Roy
1026	P. Sankaranaryanan
1027	V. D. Ravikumar
1028	Nirmal Kumar Dutta
1030	G. C. Lal Khurana
1032	Mahesh Chandra Garg
1042	Kottachery Karunakaran
1045	Narra Lenin

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate	Roll No.	Name of candidate
1048	K. Suryanarayana	1311	Hari Dev Vaid
1049	K. V. B. Satya Rama Prasad	1314	Hari Mohan Srivastava
1050	Hari Shanker Aggrawal	1322	Tarun Kumar Gupta
1056	Ram Chander Abbaraju	1323	Vidya Prakash Chawla
1062	Malyala Panduranga Rao	1333	Satya Narain Singh
1067	Konda Pitchi Reddy	1338	K. C. Balani
1070	Vishwanath Chowdekar	1341	Thakur Das Daryana
1072	C. Parameshwara Rao	1344	Dinendra Kumar Banerji
1081	Ramanujam Rengamoni	1346	Joginder Singh Bedi
1088	M. Balwantrao Joshi	1347	Hari Shankar Jha
1093	Moturu Butchibabaiah	1351	O. P. Rastogi
1102	M. V. Gopalachary	1353	Dharam Vir
1109	Yerraguntla Venkata Swamy	1354	Krishan Chander
1114	P. S. Somayajulu	1356	Krishna Kumar Agrawal
1120	Kondragunta Subbaramaiah	1363	Dilip Kumar Pain
1128	Ravi Dutt Datta	1367	Virendra Singh Khare
1132	Prem Prakash Srivastava	1372	Inderjit Malhotra
1133	Sadhu Singh	1376	D. Chandra
1137	V. R. Daithankar	1377	Javed Bahadur Singh
1158	Somendra Prasad Saxena	1383	Kasturi Lal
1170	Ramesh Chandra Srivastava	1389	Prem Parkash Nanda
1178	Shiv Shanker Goel	1390	Devindra Nath
1184	V. B. Bhatia	1396	Bertil Walters
1191	Ramesh Chandra Bansal	1398	Himanshu Mohan Baranwal
1194	Narendra Ram Anand	1400	Prem Sagar Chopra
1195	Brij Behari Lal Saxena	1402	Ram Sewak
1202	Jagbir Singh	1404	S. T. Narayanan
1203	Raghuvansh Narain Mathur	1405	Doulat Santumal Kishinani
1208	J. L. Ramachandani	1407	Indu Swarup Dikshit
1218	Jammula Padmanabham	1409	Manash Kumar Moitra
1222	Brijesh Mohan	1411	Satya Deo Pandey
1224	D. K. Ghosh Dastidar	1412	Madan Lal Batra
1226	P. A. Chacko	1415	Iqbal Singh
1241	Padma Charana Panda	1416	Mohinder Singh Mand
1243	Indra Bhan Prasad	1427	Sirvender Singh Oberoi
1248	Sampat Raj Mathur	1429	Hira Lal Sharma
1249	Basanti Lal Surana	1431	Kulbir Singh
1255	T. C. Goverdhanji Goldsmith	1438	Thularam Ram Singh
1257	Gurbux Singh	1447	J. Sankaran
1258	S. K. Vyas	1448	P. Krishnaswamy
1265	Banshi Lal Panwar	1452	S. Raghunathan
1268	Shiv Lal Borana	1456	Krishnaswamy Subramanian
1279	I. R. Krishnam Raju	1457	Rangachariar Kannan
1281	Sudhangshu Bhushan Gon	1459	S. Ramaswamy Iyer
1283	Kanailal Maity	1462	V. Veeraraghavan
1285	Pran Nath Sethi	1465	Kasturi Srinivasan
1286	Deb Kumar Chatterji	1468	K. Parthasarathy
1295	Yuvrajkrishna Misra	1471	M. B. Shelvanarayanan
1296	Om Prakash Gupta	1474	S. Venkatesan
1304	S. Thirumalai	1475	T. Munuswami Subramaniam
1307	Bhanu Pratap Srivastava	1476	Arumugam Krishnaswami

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
1478	J. A. D. Patta George
1479	T. T. Gopalakrishnan
1489	B. Bhattacharyya
1498	D. Sethuraman
1501	Srinivasa Sourirajan
1503	P. V. B. Satya Dhanapathi
1514	T. Ramanuja Krishnaswami
1517	S. Kalyana Sundaram
1520	Subal Basak
1521	Diwakar Balkrishna Tole
1524	Dada Pundlikrao Dhatrak
1537	Rajendra Prasad Dobhal
1539	Arun Govind Namjoshi
1544	I. N. Chauksey
1545	Natesa Nanjayyan
1559	V. Gopalakrishnan
1582	Tarsem Chand Chopra
1584	Gurmit Singh Saini
1593	M. Singh
1602	Kirpal Singh
1606	Gian Singh Jaswal
1611	Priya Ranjan Mishra
1612	P. C. Srivastava
1622	Hira Lal Gupta
1628	Bageshwari Prasad Panday
1631	Behara Chinna Venkata Rao
1642	Shree Ram Singh
1646	Birendra Kishore Prasad
1660	Sant Kumar Chaubey
1672	G. V. Kulkarni
1677	S. Rajagopalan
1679	G. Chandrasekaran
1686	Ratnakar Shankar Diwane
1687	Vasant Hari Gholap
1697	V. Ramaswamy
1704	Madhusudan Waman Dabak
1706	Krishnandra Pal Gupta
1729	D. D. Kajale
1730	C. G. Abraham
1731	V. K. Kulkarni
1733	Raj Pal Malhotra

Roll No.	Name of candidate
1742	Jagannath Mahadeo Pabale
1751	G. N. Seshadri
1757	Anant Lal
1761	M. M. Rao
1766	Radha Raman Prasad
1769	Shyamal Kumar Chatterjee
1777	Amar Singh
1779	A. N. Bhargava
1781	Sarbendra Kumar
1793	Kuljas Lal
1795	Y. R. K. Kashyap
1800	Subhash Chandra Mittal
1810	Brajabandhu Rath
1818	C. R. Mukhopadhyay
1822	A. S. Satheesan
1828	M. N. Halder
1831	A. K. Chaudhuri
1834	Sukomal Chandra Dutta
1835	Pradip Chandra Banerjee
1838	Kewal Krishen Kotwal
1842	A. Narayanan Kutty
1843	P. M. Zachariah
1859	N. Vaidyanathan
1862	I. S. Vivekanandan
1869	K. P. Padmanabhan
1871	C. K. Kunju Kunju Kutty
1873	K. B. Varma
1884	N. S. P. R. K. Rao Pantulu
1886	P. V. Ramana
1893	Konda Venkata Reddy
1896	A. Krishnaji
1897	M. V. Subrahmanyam
1901	Medepalli Venkata Ramana
1902	G. G. Krishna Murty
1905	B. V. Narasinga Rao
1907	T. Suryaprakasa Rao
1910	B. R. Murty
1911	P. N. Murthy
1916	Koripella Rama Rao
1919	Shyam Sundar Basak

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B

(Existing Scheme)

(Read B after each Roll No.)

1	Harendra Kumar Garg
2	Sadanand Shankar Joshi
3	Devendra Pal Singh Sengar
8	M. M. Ali
10	B. S. Anantha
14	R. Sampath Kumar
19	K. N. Shiva Shankara Rao
21	K. V. Venkata Rao

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B—*contd.*

Roll No.	Name of candidate
23	Raj Kumar
24	Seetharamiah Nagabhushana
25	M. Chandrashekar
26	Srinivasa Rangarajan
27	Ravi Kondaiah
28	Moduga Narasimhulu
29	Ramachandra Guptha
36	Thassian George
37	M. M. Reddy
39	C. P. Haran
45	R. R. Parikh
46	Abdul Hameed Abdur Razzaq
47	Pitambar Choudhary
48	Y. K. Rao
49	C. S. V. Rao
50	Surendra Nath Mehrotra
52	Jai Gopal
57	Amar Jit Singh Rana
58	Desh Prakash Gupta
59	S. S. Sahajwani
63	N. N. Neelakandan
64	K. G. Joshi
65	Vithal Jagannathrao Joshi
66	S. R. Deshpande
68	Ashok Hari Damle
70	Kishor Shantaram Tamhane
71	Damodar Anant Gadre
72	B. D. Desai
73	Anad Narsingh Gersappa
74	Sharad Parshuram Date
75	Vasudeo Vinayak Lele
76	T. V. Balasubramanian
79	M. S. Dutta
81	G. P. Singh
83	Mulk Raj Chawla
84	S. D. Shastri
85	P. V. Mehta
86	P. George Easawa
89	S. K. Roy
91	Saroj Kumar Mitra
92	Bhagwan Durgdas Motwani
93	N. R. Bose Roy Chowdhury
94	K. C. Bhattacharyya
95	Rajendra Kumar Tandon
96	Asok Majumdar
98	Amal Kumar Haldar
99	Bhola Nath Ghoshal
101	S. C. Gangopadhyay
103	Ajit Kumar Gupta
104	Kusal Kumar Nandi
110	Anil Kumar Hajra
111	Sat Pal Verma
113	Mohinder Singh Kalle
115	K. S. Dhiya
118	Upendra Nath Dixit
119	Santosh Kumar Panigrahi
121	Gedda Satyanarayana
128	G. B. Bansal
129	M. N. Ahuja
133	Darshan Singh Bhatia
134	Mani Lal
136	Vishwamber Nathh Batra
137	Padam Lal Narula
138	Krishan Lal Batra
139	Rajinder Dutt Sharma
140	Prem Chand
145	Harjit Singh
147	Prithvi Raj Malhotra
149	Anand Behari Tyagi
150	Gurubaksh Singh Chawala
151	N. S. Tyagi
153	Rameshwar Prasad Rastogi
156	Mool Ram Das Gupta
161	Mrinal Kanti Ghose
164	C. K. Puttu Rao
167	Surabhi Satya Murty
169	Kammela Venkateswarlu
170	P. Esanadev
171	T. V. Venkata Satyanarayana
172	K. B. Kosnam
173	N. W. Christopher
174	P. A. Venkatanarayana
177	Peddi Sudershan
178	J. Venkatasubbaiah
181	Sangram Vithal
183	Madivada Raghavaiah
188	Bal Mukand Garg
189	Subir Kumar Ray
192	Kapildeo Narayan Sharma
193	M. K. Nilange
195	N. R. Rangachary
196	Raj Kishore Srivastava
197	Rabinder Singh
203	Shri Nivas Sharma
205	Matwar Singh
206	Kanwal Singh
209	Sharan Kumar Gupta
211	Virendra Kumar Sabharwal
215	Gurdev Singh Hans
216	Bhava Nath Avasthi
217	Sohanjit Singh Athwal
219	V. Ramamohana Rao

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B—*contd.*

Roll No.	Name of candidate	Roll No.	Name of candidate
223	H. Madhava Rau	278	Prem Raj Singh
224	Sitarama Lakshminarayanan	279	Devendra Sharma
226	Natarajapillai Subromoni	280	Amar Pal Jayant
227	K. V. Krishnam Raju	281	Ved Prakash Varshney
228	Arunachalam Kuppuswamy	282	Chandramani Behara
232	Challa Venkata Siva Reddy	284	A. Sasidharan
236	Boggana Hanumantha Reddy		
237	Dasari Madhava Rao	285	G. Brahmaji Rao
239	Murari Venkata Rao	287	Kuldip Singh
241	G. Subbukrishnan	291	G. Gopalakrishna Pillai
255	Mukhtar Singh Randhawa	292	K. Vijayakumar
261	Ramesh Chandra Sinha	293	S. Ramachandran
263	Sarjug Thakur	295	A. Ananthanarayanan
264	Satish Narain Misra	297	Itokala Sivaramabrahmam
267	Arvind Bhagwant Patil	304	Padavala Bhavanarayana
274	Y. Bala Krishna Rao	305	A. Radhakrishna Moorthy
275	C. R. Narayanan	306	K. Radha Krishna Murty
277	R. P. Srivastava	309	Perulla Ramachandra Rao

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A

(New Scheme)

(Read NA after each Roll No.)

Roll No.	Name of candidate	Roll No.	Name of candidate
31	A. P. Panjabi	573	S. Mallikeswaran
33	O. P. Bansal	590	A. J. Virupakshaiah
157	R. L. Gupta	608	T. V. Balasubramanian
161	J. T. Ghunakikar	609	D. Chandrasekharan
166	K. L. Ganguly	617	Srinivasan Ramaswami
214	K. J. Rao	634	S. N. Narasimha Murthy
227	K. S. Udaya Shankar	679	P. Parameshwara Herle
236	K. R. Anantharaman	808	Ved Ram Gupta
237	M. N. Krishna Murthy	841	S. K. Mazumdar
249	Merugu Rajamouli	909	H. L. Minocha
251	U. Krishnamurthy	913	Satyam Kundula
256	B. R. Nagaprasanna	962	U. K. Chowdhary
266	B. Krishnaiah	968	Sukhdev Singh Walia
268	S. Krishnaiah	969	Prithvi Raj Pathak
269	Veeranna	994	K. S. Raghavan
275	K. Swaminathan	1185	V. B. Jain
278	K. Subbarayadu	1188	A. V. Chine
292	K. Parameshwara Tunga	1201	Arun Vinayak Phansalkar
297	Jasti Vishnu Prasada Rao	1221	Ghattu Narayana
311	Narayanaswamy Jayaraman	1239	Dinesh Kumar Saral
317	G. R. Murty	1256	Mulchand Tahilramani
347	T. Narayana Swamy	1295	V. S. Jadhav
356	P. N. Doraiswamy	1299	Brij Mohan Agarwal
361	H. S. Kumar	1318	N. G. Dadlani
406	K. H. Nagaraja Rao	1371	Santosh Singh Mayer
470	B. Janardhanayya	1382	R. Ahmed

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate	Roll No.	Name of candidate
1405	K. Vally	2465	Panchanan Mishra
1438	E. S. Sivaramakrishnan	2483	Smriti Kumar De
1451	Suresh Krishna Ponkshe	2529	Shiva Pratap Singh
1465	K. T. Ahuja	2643	R. C. Sharma
1474	V. B. Nibandhe	2646	G. Singh
1481	V. P. Balwatkar	2651	Darshan Singh
1484	P. T. Raju	2683	D. P. Gheer
1503	Himesh Harinand Mehta	2717	O. Kumar
1544	S. V. Joshi	2784	Krishan Lal Aggarwal
1598	M. S. Govindarajan	2821	Ram Nath Gupta
1600	S. S. Amrite	2835	Sita Ram
1610	P. Parshottam	2848	B. Harjit Singh
1653	Pradip Sen Gupta	2856	Amrit Lal Aggarwal
1677	Narendra Nath Haoladar	2886	C. P. Mahajan
1683	Dipak Kumar Basak	2890	K. S. Gill
1707	Trannath Bandyopadhyay	2909	Krishen Lal Wariku
1732	S. K. Chattopadhyay	2911	Sant Parkash
1745	M. D. Gharpure	2946	D. Dash
1746	K. K. Datta	3016	Natabar Sahu
1805	Vijai Chandra Singh	3031	N. B. Mohanty
1813	P. K. Devasahayam Lee	3057	Gurudeb Garanaik
1832	A. K. Ganguly	3067	U. Sahu
1841	D. N. Bagchi	3082	Narayan Prasad Nayak
1843	Asok Ranjan Guha	3153	Purushottam Lal Jagota
1882	Lokesh Ranjan Sanyal	3155	Raghu Vansh Roy Sikka
1899	S. K. Pal	3161	R. D. Gupta
2009	Amil Kumar Paul	3266	I. C. Gupta
2038	Dwip Narayan Pandey	3281	A. K. Talwar
2057	Pranab Kumar Ray	3321	Autar Krishen Khazanchi
2065	Ranjit Maji	3324	Jang Bahadur Singh
2095	Arup Kumar Mitra	3344	Virender Nath Katyal
2096	A. K. Das	3356	Krishan Kumar Bahal
2101	S. K. Chakrabarty	3370	Surender Pal Singh
2145	Indra Kumar Basu	3384	Balwan Singh Hooda
2219	Kalyan Kumar Sarkar	3390	Narender Kumar Atri
2230	Debabrata Bandyopadhyay	3421	R. S. Nibber
2239	H. De	3462	Satya Prakash Tewari
2259	Ananda Chattopadhyay	3476	S. S. Sahmbi
2265	A. K. Bandopadhyay	3526	G. Gupta
2278	N. Sen	3531	I. C. Menchanda
2279	K. L. Ruj	3558	Prithvi Raj
2293	Rajendra Prasad Singh	3571	Chanbir Singh Gujral
2295	H. R. Sharma	3661	Raj Kumar Gupta
2318	A. C. Ray	3669	Satish Kumar
2349	N. G. Ramakrishnan	3722	Naresh Kumar Agarwal
2351	Dwijendra Chandra Das	3764	Surendra Kumar Oberoi
2352	Sunil Kumar Bit	3775	R. Nath
2367	J. C. Sood	3874	V. K. Mathur
2411	Sushanta Kumar Roy	3878	S. K. Allwadi
2416	S. K. Arora	3928	Keshov Kumar Mathur
2437	Srikumar Mukhopadhyay	3929	Vir Bhan Sharma

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
3965	P. K. Jain
3994	Yash Pal Kakar
4102	Prem Chandra Gupta
4104	M. L. Raina
4146	Kanya Lal Bhatia
4157	Bharat Bhushan
4174	Harbhajan Singh Bawa
4176	R. K. Malhotra
4184	Rajendra Prakash
4191	Mahendra Kumar Tandon
4201	A. K. Panjanani
4233	Manoranjan Datta
4250	Amalendu Banerjee
4278	Ram Prasad Mukherjee
4308	A. D. Adhikary
4310	P. C. Rakshit
4319	Nihar Ranjan Chatterjee
4335	Jyotirmoy Mazumdar
4401	Hirak Das
4418	B. Pal
4496	B. C. Chakraborty
4520	S. K. Das Gupta
4558	G. C. Namapararadder
4567	Vasant Gundo Wadappi
4586	N. G. Maltye
4594	M. R. Gupta
4607	M. Nagendrayya
4608	Yedla Raghava Reddy
4612	K. Y. Krishna Rao
4623	Narain Singh
4635	S. Balakrishna Rao
4640	A. S. Rajanandan
4650	Nathu Ram Lath
4658	K. Gajapathy
4675	M. Satyanarayana
4699	V. S. Dwarakanath
4702	G. Rajanarsu
4707	Gudela Nageswara Rao
4708	Gaddam Allaiah
4769	M. Karimuddin
4792	R. Ramdas
4815	V. K. Aurangabadkar
4831	Marneni Venkateswara Rao
4832	Musipatla Prabhaker
5100	K. S. Jain
5102	Chokh Raj
5129	D. W. Golani
5147	M. Gupta
5149	Sharwan Lal Soni
5183	Mahesh Chandra Mathur
5188	V. P. Srivastava
5192	V. B. Agarwal
5213	F. C. Pachauri
5274	Suresh Narain Agarwal
5292	Shyam Sunder Batra
5293	Hem Raj Paliwal
5315	R. L. Poi
5317	Arunachalam Hariharan
5321	N. B. Patil
5325	Birendra Nath Karmakar
5335	H. Agrawal
5341	L. C. Raha
5342	Mulk Raj Madan
5357	T. P. Adhikary
5362	J. Sah
5410	Sohan Lal Beniwal
5424	Manmohan Lal
5465	D. N. Mathur
5474	Laxman Kundomal Gopalani
5490	Dalchand Sarma
5592	Abu Bashar
5593	G. K. Sharma
5598	Dharam Mir Manik
5601	Amreek Singh
5610	J. K. Shankdhar
5614	Chuni Lal
5634	Devendra Prakash
5672	R. N. Srivastava
5680	Pranab K. Mukerji
5714	Gwali Charan
5734	Indra Kumar Relan
5739	Ram Narain Ojha
5740	Ram Narain Sharma
5745	Hari Ballabh
5751	Alam Chand Biswas
5761	Jagdish Chandra Dhondiyal
5764	Ravi Prakash Srivastava
5802	Subhash Chander Behal
5809	A. Nath
5826	D. S. Parihar
5866	Megh Raj
5872	D. M. Pradyumna
5887	H. S. Khare
5898	Jasbir Singh Virk
5915	T. H. Siddiqui
5917	L. C. Jaiswal
5924	R. Singh
5934	P. S. Bhatnagar
5950	Ramkrishna Dikshit
5973	Brijendra Kumar Agrawal
6031	L. C. Wadhwa
6053	L. C. Bhattacharya

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

Roll No.	Name of candidate
6102	Bihari Rai
6108	Mohd. Ishaq Khan
6245	Shri Krishna Agarwal
6317	Narsingh Dass Aggarwal
6365	Charanjit Singh
6443	V. Shenbagarajan
6476	P. Mohanadoss
6478	Sudarsan Swain
6481	R. M. Mahapatra
6512	Mudayil Babu Joseph
6527	P. S. Ramaswamy
6535	S. K. Das
6539	Artatran Panda
6540	B. Ghadai
6543	A. Yesudian
6556	Khub Singh Rajput
6568	Chungath Thambi Simon
6582	P. A. Balasubramanian
6589	N. Bhooshana Kadamba
6605	Pradosh Kumar Kar
6607	Niranjan Rautaray
6639	Venkatarama Subramanyam
6641	M. S. Viswanathan
6650	A. K. Chandrasekaran
6655	K. H. Reddy
6666	V. Kuttalingam
6678	G. Patanayak
6679	K. A. Subramanian
6684	J. E. Sivaramakrishna
6694	K. V. Reddy
6698	Shri M. S. Pichakannu
6702	A. Sarvothama Shenoi
6750	A. S. M. Manohar
6755	G. Ananthakrishnan
6771	T. P. Venkataraman
6782	Prasant Kumar Rath
6787	K. Gopalan
6789	V. Santhanam
6796	A. G. Baskaran
6812	P. Hariharakumar
6821	Venkatesan Srinivasan
6824	D. Janakiraman
6832	S. B. Venkatesan
6861	Arabinda Ray
6870	K. V. Krishnamurthy
6871	N. D. Jayaram
6873	J. S. Nagaraja
6879	T. V. Kumari
6881	S. K. Keshava Murthy
6903	G. N. Seetharamu
6913	R. Chakravarthy
6925	S. R. Wakaley
6936	A. Malik
6946	Mahendra Kumar Bedi
6961	S. L. Chodpage
6967	D. P. Thakre
6971	K. Adinarayana Murthy
6980	Pratap Singh
6983	R. D. Talele
6986	Saurendra Narayan Misra
7000	S. G. Dixit
7018	Vishnu Govind Patki
7046	Nagamanickam Srinivasan
7049	K. S. Soundararajan
7052	N. A. Mahalingam
7084	S. Venkataraman
7114	Perumal Ramaswamy
7115	T. Veerabahu Murugesan
7132	S. Thamizharasan
7133	Thadimeti Sarveswara Rao
7141	R. S. Krishnan
7142	V. Rama Dorai
7146	R. Narayanan
7151	R. M. Krishnan
7154	S. Durairaj
7176	R. Rajagopalan
7184	Prakash Chandra
7251	Khushal Singh
7263	Mahabir Parsad Mittal
7291	Vasudev Mittal
7359	Harjinder Singh
7369	Surrinder Kumar Chopra
7370	K. N. Kainth
7384	M. P. Aggarwal
7470	Shiva Kumar Verma
7471	K. R. Bhandari
7474	P. Singh
7553	J. D. Kharche
7561	Madhukar Vishwanath Sant
7651	R. T. Bhakare
7704	C. Vinayak Ghodke
7709	S. Ramachandra
7744	S. B. Chopade
7803	M. Padmanabha Rao
7863	M. V. Anvekar
7877	Rabinder Kumar
7880	Om Prakash Narain
7895	Budhu Ram
7904	Dharam Pal Ghai
7909	A. C. Pal
7915	Bidya Nand Singh
7933	D. L. Mahto

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION A—*contd.*

7966	Ashok Kumar Biswas
7988	Jagdish Chandra Thukral
7989	R. Singh
8015	Sukmal Chand Jain
8028	Kailash Chand Gupta
8032	G. K. Maithel
8044	Mulk Raj Soneja
8092	J. S. Malhotra
8095	K. B. Kashyap
8126	S. K. Jain
8159	K. C. Pati
8272	Pabitra Bhushan Saha
8286	K. R. Sundaralingam
8313	Jawahar Lal Raina

8314	Mohan Ji Dhar
8328	C. N. G. K. Pillai
8342	Daniel Koshy
8353	C. Unnikrishnan
8389	P. K. Saseedharan
8391	K. P. N. Nair
8397	V. L. Thomas
8457	R. S. Nair
8492	G. C. Sanyasi Naidu
8493	G. Veerraju
8560	C. K. Rao
8571	M. Uma Maheswara Rao
8601	S. Chakraborty
8603	Shiva Prakash Vatsa

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B

(New Scheme)

(Read NB after each Roll No.)

Roll No.	Name of candidate
	Civil
18	Ram Krishha Rastogi
34	P. K. Bhatta
41	M. Purushottama
47	Badrinath Kangovi
49	B. S. Rangappa
51	K. Loganathan
52	K. T. Srinivasan
54	D. K. B. P. Jamadagni
97	D. R. Naidu
104	G. P. Bhargava
136	H. M. Joshi
142	Y. N. Somasekhara Rao
144	Dattatraya Shriram Gadre
156	P. G. Sarcar
174	Thiruvengadatha Narayanan
178	N. C. Mukherjee
192	Subodh Kumar Basu
193	M. M. Guin
198	P. K. Chakravorty
228	Panna Lal Nag
257	Ram Partap Sharma
266	Harmohinder Singh Chadha
279	Subhas Chander
303	K. Sahu
305	B. Jena
316	Nrusinha Charan Khuntia
324	Bipin Bihari Swain
332	D. Mishra

Roll No.	Name of candidate
345	Krishna Pal Singh
361	C. S. Mehta
366	R. S. Lachhiramani
369	S. K. Awasthy
375	Prem Chand Srivastava
384	Hardit Singh
385	Kishin Ranjhomal Bakhru
387	Manmohan Rai Mehta
396	M. C. Gupta
397	Gobind Ram
412	K. L. Kapur
429	Vijay Kumar Bansal
457	Sher Singh Ghai
461	H. P. Gupta
467	Jagjit Singh
468	Trilok Singh
472	Lakshmi Narain Kukreja
478	Bodh Raj Gupta
487	G. K. Kapur
490	G. D. Hingorani
492	Triloki Nath Bhatnagar
494	Inder Lal Ahuja
495	Roop Kishore
496	L. S. Mehta
497	K. K. Gupta
498	Inder Raj Sakhuja
501	G. P. Juneja
507	H. D. Sheekri
510	N. Lal
527	K. K. Wahi

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B—*contd.*

Roll No.	Name of candidate
530	Ved Mittra Mohla
531	B. S. Tomar
532	Surinder Kumar Thapar
533	Sudershan Lal Batheja
534	Surinder Mohan Sehgal
535	Pari Lal
541	Ashok Kumar Mehta
549	Rajendra Kumar Tyagi
550	Bimlesh Kumar Goel
552	Jagan Nath Garg
557	M. L. Doda
560	Ashok Bhagia
561	S. Nath
562	Tirath Raj
572	Bal Krishna Chopra
574	Jagadish Kumar Goel
583	Narendra Mohan
591	Girish Chandra Garg
596	Shiam Lal
629	H. C. Das
634	G. G. Brozobasi
638	V. S. Engineer
658	H. S. Subba Rao
669	Vegesna Ramakrishnam Raju
694	Bapanapalli Venugopal
711	M. Venkat Raju
724	C. V. Raghavacharyulu
759	Satya Pal Arya
779	Tarakanta Panda
783	Deo Kishan Joshi
785	P. R. Bora
787	Roshan Lal Depura
815	Sibadas Pramanik
818	P. Ray
835	Jagdish Prasad Awasthi
852	Brij Murari Pathak
854	Om Prakash Gupta
868	Mashal Singh Chouhan
884	Bal Krishna
891	Ram Chandra Srivastava
907	Harmohinder Singh
921	Tarsem Lal Aggarwal
928	Balvir Raj Gupta
934	D. Satpathy
939	S. Nayak
948	K. Balakrishnan
952	Duraiswamy Bhuvaneswaran
963	B. Sahu
964	K. Ravi
967	K. Jayaraman
973	V. Kannan

Roll No.	Name of candidate
982	Ramaiyengar Krishnaswamy
995	P. N. Tamhane
997	Chandrakant Damodar Kale
1002	J. G. Dahigaonkar
1003	P. H. Bade
1007	V. Sundararaman
1013	Budhi Jayaram
1023	Sagar Chand Gupta
1030	K. J. Jain
1032	Jaswant Singh Sudh
1035	Amar Jit Aggarwal
1054	Ram Kumar Thakur
1063	Mozammel Haque
1112	N. G. Halemani
1124	S. B. Patil
1138	V. H. Iyer
1142	P. K. Lalsare
1147	Sadanand Namdeo Mone
1164	K. C. Pavithran
1166	Pramod Kumar Arya
1167	A. N. Jha
1175	M. S. Kapla
1212	S. Patra
1215	Krishna Chandra Jha
1234	S. U. Nair
1239	C. S. R. Nair
1244	A. K. John
1249	T. Paulus
1250	P. G. Krishnan Nair

Mechanical

Roll No.	Name of candidate
1287	Sant Prashad Gupta
1288	N. R. Sharma
1297	S. N. Nagarajan
1306	D. V. S. Gangadhara Sharma
1311	Praturi Rajaratnam
1312	K. L. Sethi
1313	J. Swaminathan
1330	K. Mani
1334	R. A. Shariff
1339	G. H. Renukesh
1343	A. Srinivasa Murthy
1344	K. A. Suryanarayana
1345	Krishnamurthy Ramaswamy
1347	K. Ramanathan
1359	V. S. Rao
1360	Padmanabhan Sivadasan
1364	Viswanathaiyer Ramaswamy
1365	J. Madhusudhan Reddy
1372	Bhola Mandal
1379	Mahendra Krishnan

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B—*contd.*

Roll No.	Name of candidate
1394	Rameshwer Dass
1400	S. Sivarajan
1407	Vijay Kumar Bhalla
1413	V. Sundararaman
1417	Arun Govind Joshi
1420	Kapal Dev
1422	Pushpinder Pal Goswamy
1425	B. K. Ghaiya
1428	K. S. Anand
1429	Baldev Raj Sharma
1432	J. K. Chandnani
1459	P. K. Korgaonker
1465	Kuppuswamy Makarabushanam
1476	S. F. Pardawala
1477	Raghu Bhojraj Narlani
1486	Venkitachalam Raman
1488	Dilip Kumar Adhikari
1491	M. V. Radhakrishnan
1493	A. P. Vazirani
1529	Ranjit Sen Gupta
1536	Samir Prasad Ganguly
1545	P. K. Datta
1554	A. D. Bhhattacharya
1564	Sahadev Paul
1576	S. C. Bhatia
1581	B. K. Pal
1587	C. Chakraborty
1595	S. S. Bagchi
1598	Ranjan Kanti Chakravarti
1639	R. Singh
1646	A. Bholo
1647	H. Sahu
1648	B. Dutta
1649	Inderjit Singh
1659	Narinjan Singh
1677	R. L. Khitha
1689	M. L. Dua
1696	Dev Raj Singla
1702	S. S. Bihal
1720	Rabin Chanda
1721	Pranab Kumar Sarkar
1734	Erusu Salleswar
1737	M. Z. Baig
1750	Manne Rama Rao
1751	Marella Nageswara Rao
1752	Erukulapaty Venkateswarlu
1760	K. A. K. Verma
1763	C. Nageswara Rao
1767	Vasu John Koteling
1770	Parekadavil Thomas George
1792	D. S. Rao
1805	N. C. Roy
1811	O. P. Harkut
1816	S. K. Salwan
1827	M. K. Balasubramanian
1845	M. Singh
1850	G. C. Mathur
1854	Ram Pratap
1856	K. V. Vyas
1864	M. Vishwanatharao Joshi
1866	B. P. Jain
1871	Narinder Singh
1885	Dhanpat Rai
1899	J. Kapoor
1901	S. S. Biah
1913	Dev Kumar Anand
1914	B. M. Goyal
1916	Ram Lal Verma
1917	Chandra Pal Singh
1919	Rabindra Nath Mazumder
1921	Satish Kumar Khurana
1956	Senapati Jaganath Rao
1985	H. L. Udupa
1994	Gopalanandan Mudaliar
2002	A. V. Thirumalai
2005	G. S. Sandhu
2011	R. K. Rajput
2012	Ananta Dattatrya Joshi
2017	B. P. Mandal
2027	Sharad Sadashiv Deshpande
2030	P. H. Joshi
2031	Nishikant Narayan Kale
2049	S. K. Mudakappanawar
2055	Arun Krishnaji Gapchup
2061	D. P. Bhardi
2066	Brahma Prakash
2082	A. K. Sinha
2086	C. Kumaran Dasan
2100	Sala Chandra Sekhara Rao
2104	M. Y. Prasada Rao
2107	P. V. Narasimha Rao
2583	Golla Munikrishnudu

Electrical

Roll No.	Name of candidate
2119	B. R. Monga
2133	B. K. Balaram
2139	K. L. Narasimhan
2144	C. Balasubramanya
2154	G. Narayan
2159	H. N. S. Rajaiah
2167	R. H. Raja Rao
2170	H. S. Ramaprasad

ASSOCIATE MEMBERSHIP EXAMINATION—SECTION B—*contd.*

Roll No.	Name of candidate
2180	T. C. Reddy
2188	Deo Sharan Singh
2193	Balbir Singh
2197	S. V. Athavale
2202	P. U. Jadeja
2221	Surendra Kumar Girdhar
2223	G. C. Pande
2227	G. Srinivasa Rao
2239	Govind Prasad Agrawal
2253	R. Lakshminarayana Ayyar
2262	Jagir Singh Dadhiala
2265	P. Shetty
2278	Roshan Lal
2283	S. V. Pandit
2284	M. Kuppuswamy
2317	Bhakta Ranjan Saha
2330	D. M. Ganguly
2332	S. Koteswar
2353	S. C. Basu
2358	Parbodh Chandar Mandahr
2365	A. J. S. Dhaliwal
2366	Darshan Singh
2367	Harjit Singh
2372	Prithvi Pal Rawlley
2373	T. S. Thind
2393	Vijai Kumar Gangal
2402	Yudhishtar Raj Soni
2404	K. S. Sundareswaran
2407	Roshan Lal Thapar
2409	Ashok Kumar Bhambri
2415	Jawala Singh Sekhon
2416	G. L. Arora
2422	R. L. Garg
2423	L. C. Gupta
2431	Yogesh Chandra Agarwal
2433	P. K. Seth
2434	Harbanslal
2447	R. R. Kandade
2452	Md. Shafiq Saddiqi
2485	Pabbisetty Ahobala Rao
2499	Khanderao Sonu Nigade
2505	Chittepu Narayana Reddy
2527	J. K. Ghosh
2531	Prem Nath Soni
2543	Suraj Prasad Nigam
2557	J. K. Jairath
2565	Atma Ram
2572	Jagadesan Nithyanand Iyer

Roll No.	Name of candidate
2603	A. Unnikrishnan
2608	Panchapakesan Rajam
2613	V. Subramanian
2616	Uppalapati Rama Rao
2624	T. S. Sethi
2635	K. C. Bansal
2637	Jagdish Rai Kohli
2649	Kapil Deo Singh
2654	Gurbaj Singh Kamboj
2672	Braham Dutt Sharma
2673	P. K. Bhuyan
2676	Godavarty Kondayya
2690	K. Chandra Singh Yadav
2697	M. Neelakanda Balagopalan
2708	V. K. Reddi

Chemical

Roll No.	Name of candidate
2719	Janakiram Sundarraman
2722	Amrik Singh
2727	D. K. Kohli
2729	P. N. Mahrotra
2733	Ranjit Kumar Chakrabarti

Metallurgical

Roll No.	Name of candidate
2743	Y. J. S. Madhavachar
2744	R. N. Prasad
2747	K. K. Vasu
2750	P. K. Chatterjee
2753	Pratap Chhandra Mitra
2760	Krishna Gopal Choudhury
2761	A. K. Ganguly
2763	B. B. Singh
2769	Om Parkash Chugh
2772	Sanjoy Kumar Das
2777	T. K. Barat
2784	C. S. Sivaramakrishnan
2789	P. S. Viswanathan

Electronics & Telecommunication

Roll No.	Name of candidate
2795	Dharam Paul Mehta
2796	M. C. K. Paul
2800	Sushil Kumar Chakravarty
2806	D. S. G. Rao
2810	P. Nadarajan
2813	Pranab Nath Chakravertty
2819	Kali Das Mukherjee
2820	H. P. Misra
2826	Kishor Damodar Gujar

OBITUARY

The sympathy of the Institution is extended to the relatives of those whose passing is recorded here

Shri P. C. Agrawal

Shri Punam Chandra Agrawal, B.Sc., M.B.E., C.E., I.S.E., M.I.E., died on December 11, 1965.

Born in 1896, Shri Punam Chandra Agrawal did his B.Sc. in First class from Agra University in 1916 and qualified in Civil Engineering from T.C.E. College, Roorkee in 1919. He had his practical training in U.P. Irrigation Branch for one year. He served the same department as an Assistant Executive Engineer from 1920-26 and during this period was responsible for construction of Kheri Branch, Sarda Canal. In 1926, he was promoted as Executive Engineer and during tenure of his office in this capacity he was incharge of several divisions in Irrigation Department, U.P. and was responsible for construction of two power houses, a weir, a pumping station and a number of tubewells. He was then promoted as Superintending Engineer and later as Chief Engineer of Irrigation Branch, U.P. In 1950, Shri Agrawal had retired from his service. In 1955, he was appointed as Chairman, Rates and Costs Committee, Ministry of Irrigation and Power, Government of India. He was also the Member, Bhakra Nangal High Power Committee. He practised his engineering skill as a Consulting Engineer at Agra.

Shri P. C. Agrawal joined the Institution as Associate Member in 1922, and was transferred to Member in 1935. He was the Member of the Council in 1948. Since 1951, he was the Life Member of the Institution.

Shri John L. D'Sa

Shri L. D'Sa, B.E., B.Sc.(Hons.) Engg., M.I.E., died on January 13, 1966.

Shri D'Sa obtained his B.E. degree in Electrical Engineering from Madras University in 1928. He worked in Doddaballapur Town Electrification and was selected as Damodardas Scholar in 1930. He passed B.Sc. (Hons.) Engg. from Birmingham and stood first class first in the university. Shri D'Sa was President, Indian Association, Birmingham in 1933-34 and deputed to Italy as Indian Student Representative from England. He specialised in Sweden for 5 months on Erection and Testing of Hydro Electric Equipment. In December 1934, he was appointed as Sub-Engineer, Sivasamudram. In September 1938 he was posted as Asstt. Superintendent of hydraulic works and was transferred to Sivasamudram as Hydraulic Engineer in February 1942. From March 1943 to September 1944, he was deputed in England to inspect the equipment for Mahatma Gandhi Hydro

Electric Works and was posted as Superintendent on his return. In December, 1949, he was promoted as Superintending Engineer in charge of construction and administration and then transferred as Superintending Engineer Sharavathi Valley Project in May 1959 where he was responsible for Estimates and Design. In April 1956, he was promoted as Chief Engineer, Electricity Department. In 1957 on the formation of electricity boards, he was appointed as Technical Member of Mysore State Electricity Board. In March 1961 Shri D'Sa was appointed as Chief Engineer, Mysore State Electricity Board and was responsible for all major works in the Board.

Shri D'Sa joined the Institution as Member in 1954. He was closely associated with the activities of Mysore Centre and was continuously the Member of the Executive Committee from the year 1958. He was the joint Honorary Secretary of the Mysore Centre for 1964-65 and was the Council Member of the Institution in the year 1965.

Shri T. J. Mirchandani

Shri Tolaram Jethanand Mirchandani, M.A., M.Sc., O.B.E., M.Sc. (Eng., (London), M.I.E.E., M.I.E., died on October 22, 1965 at the age of 69. He was a Member for Life of the Institution.

Born in 1896 at Talsi, Sind, Shri T. J. Mirchandani passed his M.A., in 1919 and M.Sc., in 1920 from Bombay University. He took his M.Sc. (Eng.) degree from London University in 1924. He had his apprenticeship training from 1924-26 at Manchester. He worked as Assistant Professor of Electrical Technology, Indian Institute of Science, Bangalore from 1927. In 1929, he was elected as Associate Member of Institute of Engineers, London. He served the Madras Electricity Department as an Executive Engineer in 1931-39, as Superintending Engineer, Mettur in 1939-40, as Deputy Chief Engineer in 1940-41, as Superintending Engineer, Pykra in 1941-42, as Chief Electric Inspector, Government of Madras in 1942-44 and as General Superintendent, operation system in 1944-45. He became Full Member of Institute of Engineers (London) in 1944. In 1944-45, Shri Mirchandani was Chief Engineer, Bombay Electric Grid, Bombay. He was appointed Chief Engineer, Electrical and Mechanical Department, Government of Rajasthan in 1955. He retired in 1957.

Shri T. J. Mirchandani joined the Institution as Member in March 1957, and became Life Member in 1958.

BOOK ACKNOWLEDGMENTS

1. **Railway Engineering.** Shahane and Alexander, *Allied Book Stall*, Poona, Rs. 7, 634 pages.

This book, as its name implies, deals with railway engineering. The examination papers of Poona, Bombay, Madras, and other universities of India are appended. F.P.S. units have been used throughout.

2. **Surveying and Levelling—Part 1.** T. P. Kanetkar and S. V. Kulkarni. *A. V. Griha Prakashan*, Poona, Rs. 20, 22nd edition, 1965, 624 pages.

This revised edition of the book gives the details of the surveying instruments calibrated in metric units and how to use them under various circumstances. Illustrative examples have been added and practice exercises have been given at the end of each chapter. The book meant for students will also be found useful by practising engineers.

3. **Estimation and Valuation.** R. H. Namavati. *Universal Book Corporation*, Bombay, Rs. 10, 1965, 436 pages.

An architect or an engineer has twofold duty to perform in carrying out a building project, namely, planning in the office and tackling various problems for its successful execution at the site. This book includes the information on topics like valuation, rate analysis, estimating, tenders, etc. It is meant for the students, and also for the men in profession.

4. **Fluid Mechanics—Theory and Problems.** S. C. Jain. *Nem Chand and Bros.*, Roorkee, Rs. 12.50, 1965, 340 pages.

This book in metric system of units, conforming to the requirements of the under graduate classes is also meant for students intending to appear in the competitive examinations. A good number of worked out examples explaining the principles of the subject and their practical applications have been included.

5. **An Introduction to Heat Engines.** K. P. Roy. *Asia Publishing House*, Bombay, Rs. 12, 1965, 352 pages.

This book aims at a comprehensive study of the theory and practice of heat engines in a single volume and includes chapters on thermodynamics, boilers, reciprocating engines, condensers, air compressors, refrigerators, etc. It is primarily meant for the Indian students preparing for engineering diplomas but is also useful for students of degree courses. Solved examples, and selected questions from various sources have been included. The book is in metric system of units.

6. **High Dam at Aswan.** Tom Little. *Methuen and Co. Ltd.*, London, 30 s., 242 pages.

In this book in four parts, the author, a journalist who has specialized in middle eastern affairs and watched the Aswan Dam since the birth of the idea, has described the design of the dam from a non-technical pedestal, the political conflicts preceding its execution, and its construction.

7. **Techanical Thermodynamics.** V. V. Sushkov. *Gordon and Breach Science Publishers*, New York, $12.50, 1965, 396 pages.

This book in metric system of units, deals with the basic gas laws and the laws of thermodynamics, and their application in heat engines and refrigeration, etc. Useful appendices have also been included in the end of the book.

8. **Basic Electrical Engineering.** A. Kasatkin and M. Perekalin. *Gordon and Breach Science Publishers*, New York, $9.50, 1965, 500 pages.

This book gives a detailed description of the theory and practice of direct and alternating current. The subject matter has been graded in a logical sequence. Various illustrations have been included to make the whole subject easily understandable.

PUBLICATIONS RECEIVED

A copy of Technical Note No. 24 entitled 'Water Pollution Control in Thailand' by M. B. Pescod has been received from the Seato Graduate School of Engineering, Bangkok, Thailand. In this note an appeal is made to initiate pollution control measures in Thailand and methods whereby this can be accomplished.

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, industrial and other organizations employing engineers. It is hoped that employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

SITUATIONS WANTED

YOUNG ENGINEER, Graduate Member of both the Institution of Civil Engineers and the Institution of Structural Engineers, with seven years experience in P.W.D. and five years experience with a London Consultant as R.C. Designer-Detailer, wants to join a civil and structural consultant or contractor in Calcutta at four-figure salary per month. Write to K. Ray, 192 Galliard Road, London, N. 9, U.K.

ENGINEER, age 41 years, with qualifications B. Sc. (Hons.) with Honours in Chemistry of Calcutta University, B. Sc. (Engg.) in Mechanical and Electrical Engineering from Benaras Hindu University and A.M.I.E. (India), having more than 3 years experience as Assistant Engineer in industry, 9 years in a railway training organization and 3½ years as Principal of a polytechnic, seeks a suitable change in a training organization of major industry or technical institution. Expected salary Rs. 1,200 per month. (Office ref. E.S. 224)

YOUNG SCIENCE GRADUATE, age 32, passed Sections A and B of the Associate Membership examination of the Institution of Engineers (India) and diploma in Electrical and Mechanical Engineering of the Jadavpur University, having 10 years experience (including engineering apprenticeship training) in the maintenance and erection of mechanical and electrical machines and plants, seeks suitable change. (Office ref. E.S. 225)

ELECTRICAL ENGINEER, age 31 years, Associate Member of the Institution of Engineers, desires a change of employment. Presently employed as a Senior Assistant Engineer in one of the leading Composite Textile Mills in South India. Experience for 10 years in the electrical maintenance, electrical construction, electronics and instruments departments. Recently deputed for training in Electronic Process Controls in West Germany. Minimum salary expected Rs. 1100. (Office ref. E.S. 226).

YOUNG B.E. (Elect.), A.M.I.E., Flight Lieutenant, Signals Officer in the Indian Air Force Technical Signals Branch with 9 years of service experience on maintenance of radio and radar equipment, technical administration of signals section and including two years of teaching experience of technical graduates in Air Force Technical College in electronic subjects, with additional one year teaching experience in engineering colleges and diploma institutions ; last salary drawn Rs. 1,095 ; seeks suitable employment. (Office ref. E.S. 227)

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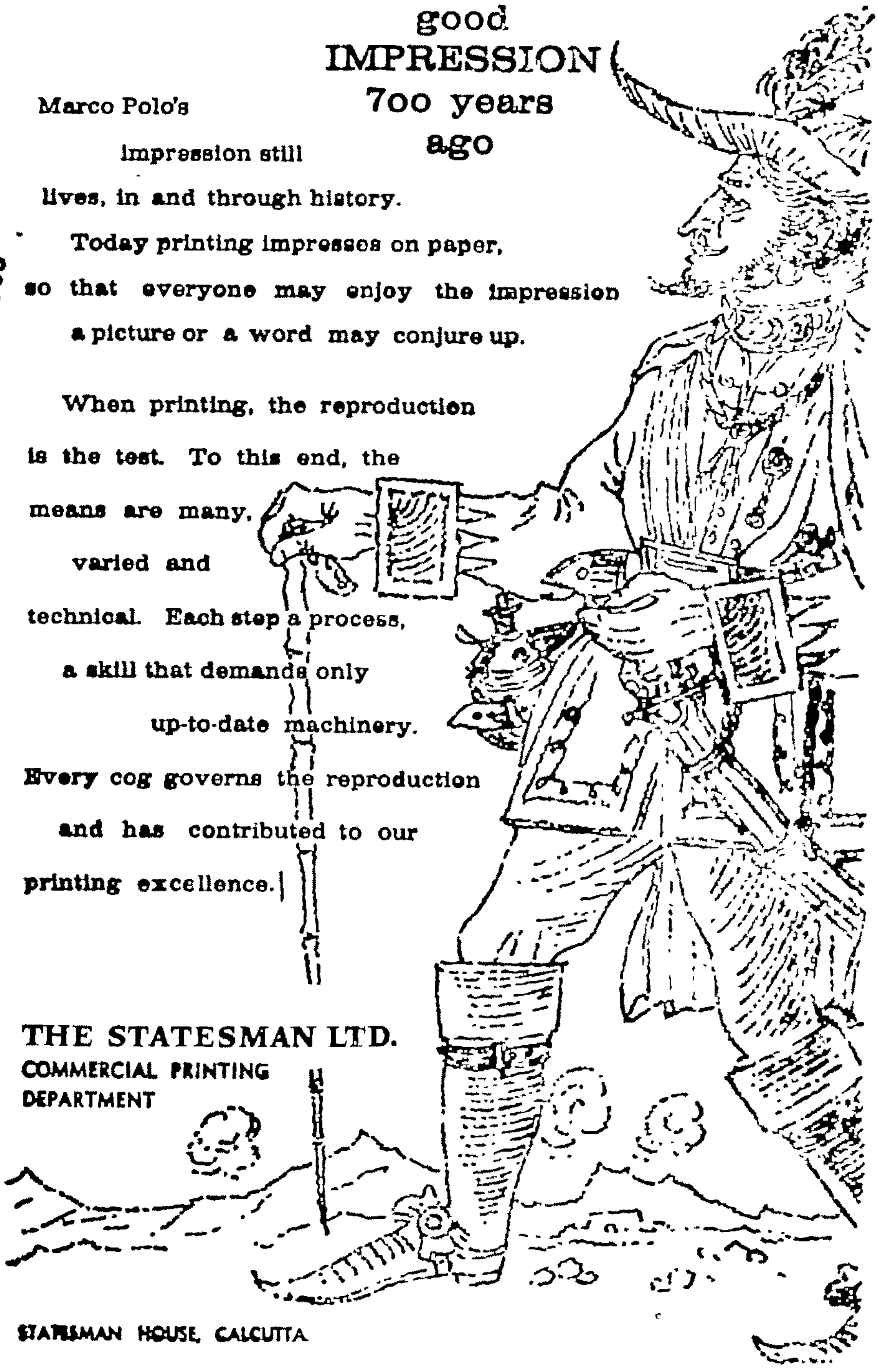

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A LIGHT WITH WHICH HOLES CAN BE BORED

D. Fishlock

Non-member

Men, for decades, have dreamed of a ray that could be 'fired' to kill an adversary, perhaps, or even knock out an engine. But its likelihood appeared incredibly remote to the scientist; it just did not seem possible to 'beam' enough energy through the atmosphere for any appreciable distance—at least without using something as big and costly as an atom-smashing machine. Then, in May 1960, the laser—light wave amplification by stimulated emission of radiation—was invented.

The laser is an invention for generating light; no ordinary kind of light, however, but a very powerful and pure kind, never found in nature.

Whereas sunlight or the light from an electric lamp is a confused jumble of waves of different wavelengths (or colours), that emerge haphazardly, the laser's light is an orderly emission at one wavelength only. Hence it is very pure or 'coherent' compared with the 'incoherent' light we meet every day.

It has another peculiarity too: it emerges as a very narrow shaft which, unlike a torch or searchlight, shows little tendency to fan out. Indeed, so slight is this tendency that if a laser were pointed at the moon the 'spotlight' falling on the moon's surface would be less than two miles (3.2 km.) across.

Today, only about five years after its invention, there are hundreds of laboratories in the world investigating the laser. It is an invention that excites the imagination of almost every scientist in a way perhaps no previous discovery has done. In Britain there are now at least a score of research teams exploring the laser; some of them are now contributing importantly to this exciting new field of laser physics.

Several types of laser are available—solid, liquid, gaseous and semiconducting—but the most popular is still the original one, the heart of which was a slim stick of ruby 2 in. (5 cm.) long.

This was not a natural ruby, however, but a synthetic crystal, painstakingly grown in the laboratory. Pink, not red, in colour, it contained much less of the colouring matter of the natural gem. It is this colouring matter, one part of chromium in 2000, that generates the coherent light when suitably excited by an intense flash of ordinary light—from a photographer's flash lamp, for example.

Although it is the 'coherency' of the light that attracts many scientists who want such light as a research tool, other considerations have been more directly responsible for the rapid development of the laser.

There are several quite different facets to the extraordinary character of the light that it emits, each of which endears the invention to different fields of science.

Without doubt the most spectacular in its results is that the light emerges as a very narrow shaft that remains almost parallel. Such a shaft can be focussed very sharply with an ordinary lens—to a pinpoint the diameter of a hair or less.

The tremendous amount of energy that is stored in the ruby laser and emitted in a brief burst is thus focussed over a very small area, and in this way it is quite easy to exceed locally the boiling point of any known substance. The most powerful laser built so far emits bursts of energy of about 1,000 joules; in comparison, the rifle bullet has a kinetic energy around 5,000 joules.

Experimentally, the laser has bored holes through diamonds, set carbon on fire, welded refractory metals and drilled through a steel girder. It has also sliced through living tissue—and may one day make possible 'knifeless' surgery that simultaneously parts and cauterizes the flesh, or selectively removes a tumour.

It is experiments of this sort that have given rise to speculation about gigantic lasers that might shoot down an aircraft or missile. On theoretical grounds, however, such a weapon must be immensely costly and inefficient.

Another field where the laser is showing great promise is communications, where a continuous beam of light is known to have an incredible capacity for information, such as telephone or television signals but ordinary, 'incoherent' light is far too much of a jumble to be useful. The narrow shaft of the laser's light, however, if emitted as a continuous beam, could be a most effective 'carrier'. Another sort of laser is needed here, such as a gas laser or semi-conductor laser, both of which can emit light continuously.

At the moment, the big problem is to find a way of putting speech or vision signals on to such a beam, and to take them off again; once solved—and there is good promise that the solution is not far away—the way is open for 'optical cables' for use, first, in space, where there is no atmospheric contamination to interfere. Eventually, they will be used at ground level, probably with the light carried through pipes to avoid interference from fog or other atmospheric conditions.

A third application that is showing rapid progress is for optical 'radar', where the laser provides a powerful source of energy that can be bounced off any opaque target to provide a sharp 'echo' or reflection. There are plans afoot to map the moon's surface from a satellite in this way.

A type of instrument that promises to find wide application is an optical range-finder. Here the laser is used to measure accurately the distance to an object perhaps 5 miles (8 km.) away. It could be invaluable to a surveyor. One such instrument is being developed by a London firm, specifically for surveyors, and will consist of a laser pack that can be carried by one man and will measure distances up to 5 or 6 miles (8 or 9.6 km.) with considerable precision.

Many other possible applications of this remarkable instrument have been suggested, including its use in chemical engineering, in photography, in printing, for guiding aircraft, ships or spacecraft, and in many fields of research. But many more still remain to be discovered.

WIND DAMAGE TO BUILDINGS*

Introduction

The severity of wind storms in Australia is fortunately such as to impose no great difficulty in the provision of storm-resistant construction. Reports of damage to buildings nevertheless follow the occurrence of winds of gale force. A distressing feature of the personal and community loss sustained in this way is the knowledge, derived from both local and oversea experience, that many form of windstorm damage are avoidable. The evidence indicates that most forms of permanent construction will survive severe wind storms if the elements of construction are securely connected, and windows are shuttered where flying debris might be encountered.

This paper discusses some of the effects of wind on buildings, and directs attention to precautionary measures against wind damage to houses and other small buildings of similar construction. The diversity of storm severity in different regions precludes firm recommendations being made herein, and readers should be guided by the local history of storm damage when considering the implemention of principles outlined here.

Types of damage

The most common form of wind damage is damage to roofs. In regions where cyclones are experienced the damage extends from the breakage of windows to the partial or complete destruction of buildings. Buildings under construction are particularly vulnerable to damage, especially while masonry is 'green' or before doors and windows are fitted, or if wind strikes before bracing is secured.

Wind-blown sand can be highly destructive. It can strip paintwork and galvanizing, and 'sand blast' the panes of windows to the point of affecting transparency. Blown sand will clog the actuating mechanism of louvres, and unless sand is prevented by eaves soffits from entering the roof spaces it may lodge on ceilings in quantities sufficient to cause the collapse of ceilings.

Wind-storm regions

Coastal areas of Australia are particularly subject to high winds, those severities are greatest in northern regions. These winds occur with seasonal regularity and are regarded as a feature of the local climate. The forces that winds might on buildings can be forecast by calculation, but the precise direction from which they might blow can be in some doubt.

Another type of wind storm is that which occurs suddenly and is experienced over a limited area only. This type of disturbance is a vortex a few hundred feet wide in which air rotates at a very high speed for a short time, while the vortex travels forward a limited distance only. Such disturbances are unpredictable as to time and place of occurrence, and are very damaging because of their rotational nature. The wind forces are largely unpredictable, and building owners are well advised to maintain their properties in good structural repair where such storms are known to recur.

---

* Reproduced from 'Notes on the Science of Building', no. 88, January 1966, published by the Department of Works, Commonwealth Experimental Building Station, Chatswood, N.S.W., Australia.

Forces involved

The publication SAA Int. 350, Interim Code for Minimum Design Loads on Buildings, specifies the wind loads that buildings in Australia should be designed to resist.

This is done by the specification of: (i) a wind velocity, for purposes of design, for each of a number of geographical regions and topographical conditions; (ii) a formula for the conversion of wind velocity to wind pressure; and (iii) form factors, to be applied to the deduced design wind pressure, to designate the manner in which wind pressure is distributed over and within buildings of different forms.

The wind velocities recommended by the code for purposes of design are set out below, together with the equivalent wind pressures deduced from the formula $P = \frac{V^2}{400}$, where P is the pressure in lb. per sq.ft., and V the velocity in miles per hr.

Wind velocities and equivalent pressures for use in design

Conditions of exposure	Coast South of Lat. 25°S and inland		Coast North of Lat. 25°S	
	Velocity, m.p.h.	Pressure, lb. per sq. in.	Velocity, m.p.h.	Pressure, lb. per sq. in.
(a) Natural protection against full effect of wind	65	10	95	22
(b) Average conditions of exposure situated on flat or gently undulating country	75	14	110	30
(c) Extreme exposure—situated on sea coast or estuaries, at or near top of steeply sloping ground or where natural configuration of the ground is likely to increase wind velocity	90	20	130	42

The windward wall of a building is subjected to a positive pressure and the leeward wall to a negative pressure (or suction) which act in unison in the direction of the wind, and exert on the building a combined pressure some 20% in excess of the equivalent pressure of the wind. Wind pressure on roofs is predominately a suction effect which approximates 40% of the equivalent pressure of the wind, except that the suction effect on the windward slope of a roof is replaced by a positive pressure at slopes that exceed 20°-30° to the horizontal. The magnitudes of pressures within a building are determined by the proportion of openings in external walls, as these openings permit external pressures to be communicated indoors. The failure of a window pane, door or wall cladding during a wind storm can suddenly subject other elements of the shell of the building to considerably increased pressures, and more directly to the gustiness of storm conditions.

Projecting construction, such as eaves, is subjected to high wind loads, because of the simultaneous action of wind pressure under eaves and of the suction effect induced by the flow of air over the roof. The most severe suction effect induced on a roof can occur when wind blows somewhat uniformly onto two adjoining walls of a building. This suction effect, which is limited to an area of the roof near to the windward corner of the building, can be several times the value of the equivalent pressure of the wind.

The rotational nature of the extensive air mass of a cyclone leads to the situation where a building may encounter gale-force winds from any quarter, depending on the path of the cyclone. When the centre of a cyclone passes over a building, the progress of the cyclone will subject the building firstly to wind from one direction, and subsequently to wind from the opposite direction, with a period of claim intervening.

Some aspects of storm damage have revealed insufficient attention to the likely magnitudes of wind pressure. Consideration might be given here, by way of example, to the case of machine room on top of a building. The usual need for copious ventilation will result in a high uplift force on the roof, applied from within the plant room, which will act in unison with the suction effect induced by the flow of air over the roof. The acute suction effect stated earlier.

Some important details

Anchorage

Local practices may, to a degree, provide precedents for the design of buildings to resist storm damage, but it is pertinent to note that memory of past severe storms might not be sufficiently long to include storms of extreme severity which occur very infrequently. The broad objectives in the provision of anchorages is to tie securely together all elements of a building, and to prevent lateral movement and overturning of a building as a whole. Outbuildings pose a problem; storm-resistant construction may be uneconomic for them, yet if they are nót so constructed, they may give rise to flying debris, and thereby seriously damage principal buildings~~.~~ and more importantly, cause injury to people.

Roof cladding

Concrete-slab roofs are usually of such weight as to ensure their stability under storm conditions. The hazard lies rather in the partial loss of the roof membrane or of overlying material used to protect the membrane from sunlight. The adequacy of local practices for the fixing of roof cladding should be examined. In the case of roof tiles, it would be good practice to secure every tile. Corrugated roof sheeting should be screw-fixed rather than nailed, and special attention might be given to the close spacing of fixing clips of strip-metal roofing and to the securing of the clips to the roof framing. Fixings at close centres are specially needed around the perimeter of roofs not protected by parapets, and for rolled or turned edges, closely spaced fixings are essential beyond the line of external walls.

Roof framing

Roof framing that has become traditional in Australia is the product of craft practices that have proved adequate in general service. The ultimate strength of such framing is somewhat unknown, it being determined largely by the efficacy of skew-nailed connections made between members. On this account, various forms of supplementary fixings are employed where experience or the prevalence of severe storms suggests the need for greater assured strength. Precautionary measures include the double-nailing of connections, and, the use of fixing, devices such as galvanized-steel wire of flat straps, spike connectors, or pressed-steel anchor plates at alternate joints or crossings of members.

Tying to walls

The manner of securing roof framing to external walls is dictated by the materials from which the walls are constructed. Special attachments to supplement nailing are best located over external walls beside each rafter, and devised to pass over the rafter and a purlin or batten at that point. Steel rods, [illegible] in. in diameter, have been used for the purpose. The rods are stapled to the timber members that they bind, and they are screwed one end in the case of timber-framed walling, to facilitate bolting to the top plate. Top and bottom plates are secured directly by bolts, or are secured by straps or other attachments to the studs. The attachments described are appropriate to concrete hollow-block walling also, except that the rod anchorages are hooked and bedded in the reinforced concrete bond beam which should be continuous around the tops of external walls. It can be prudent to provide tie rods between the bond beam and footings, to secure the roof as a whole (Fig. 1).

Roof construction that is carried on 11 in. brick-cavity walling may be secured to top plates, generally as described above but the practice of tying top plates by means of hoop-iron straps to some six courses only of brickwork is likely to be inadequate particularly where sheeted roofs are involved. An adequate number of courses of brickwork for purposes of anchorage will at times not be available, because of the presence of window openings, and tie rods should be provided between top plates and footings.

Securing the structure

The tendency for a framed building to move laterally on its supporting walls or piers is resisted by bolts that extend between the bottom plates and the footings or piers. Alternatively, the bolts may connect with the floor bearers when separate connectors are provided between the bottom plates and the bearers, or the top plates are bolted directly to the floor bearers. Piers or stumps should be set well into the ground, to guard against the overturning of the structure as a whole. Holes formed in ant capping for the passage of holding-down bolts should be sealed with solder or with a poison gout Figs. 2 to 4.

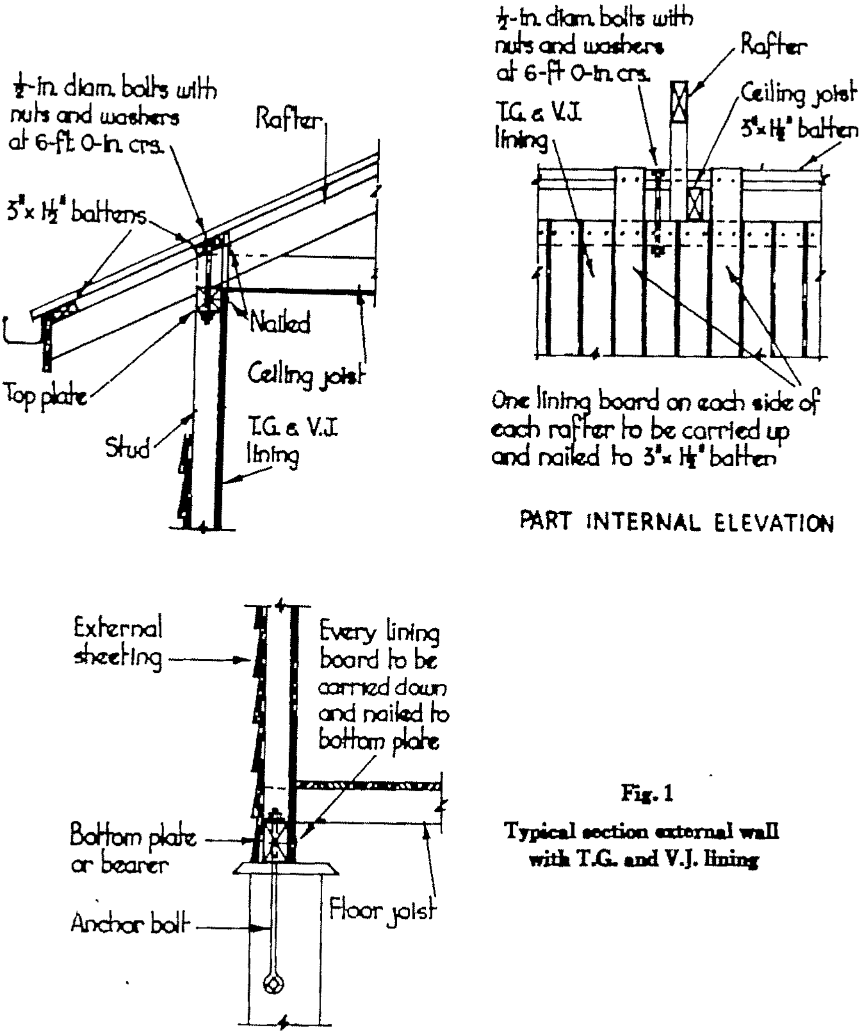
½-in. diam. bolts with nuts and washers at 6-ft 0-in. crs.
Rafter
3"x 1½" battens
Nailed
Ceiling joist
Top plate
Stud
T.G. & V.J. lining
½-in. diam. bolts with nuts and washers at 6-ft 0-in. crs.
Rafter
Ceiling joist
3"x 1½" batten
T.G. & V.J. lining
One lining board on each side of each rafter to be carried up and nailed to 3"x 1½" batten
PART INTERNAL ELEVATION
External sheeting
Every lining board to be carried down and nailed to bottom plate
Bottom plate or bearer
Anchor bolt
Floor joist

Fig. 1
Typical section external wall with T.G. and V.J. lining

Nails

Galvanized flat-head or spring-head nails, and not jolt-head nails, should be used to secure metal straps and fixing brackets to timber. Experience has shown that corrosion around nail holes can result in fixings pulling clear of small-headed nails. As high humidity is a characteristic of windstorm regions, it is desirable to inhibit possible corrosion at fixings by the application of bituminous or other anti-corrosion paint to vital metallic components.

Other construction

The general principles outlined above should be applied to verandahs and porches, and to boxed eaves soffits and permanent awnings. Roller blinds, collapsible awnings, and the like should be installed with robust securing straps, or be removed when gale-force wind are imminent. Their failure under wind load may lead to further damage, particularly to windows and doors.

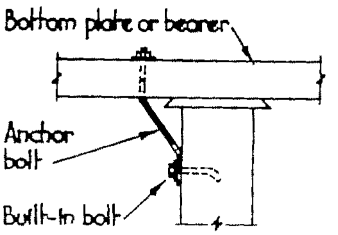

Fig. 2

Anchor bolt and fixing for concrete stumps

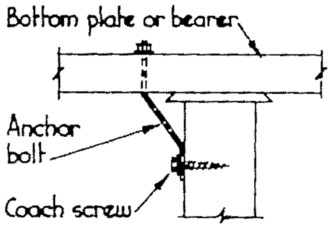

Fig. 3

Anchor bolt and fixing for wood stumps

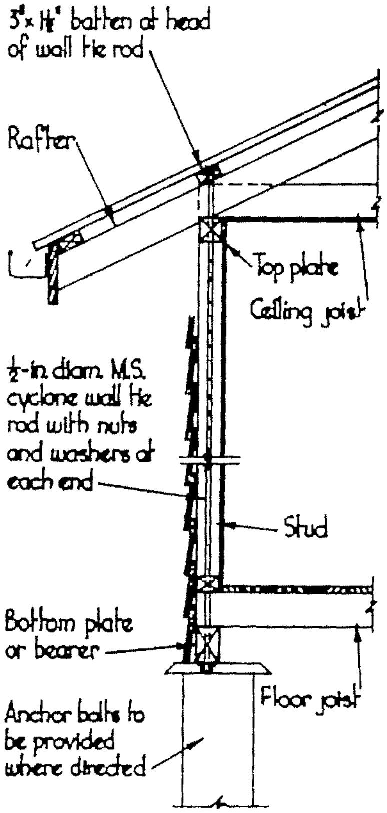
3" x 1½" batten at head of wall tie rod
Rafter
Top plate
Ceiling joist
½-in diam. M.S. cyclone wall tie rod with nuts and washers at each end
Stud
Bottom plate or bearer
Floor joist
Anchor bolts to be provided where directed

Fig. 4

Typical section of external wall with other than T.G. and V.J. lining

Glass is a relatively weak material in the present context, but its performance under wind load can nevertheless be anticipated from data supplied by leading manufacturers. The principal variables are the dimensions of the pane, the thickness of the glass, and the exposure of the glass to wind storms of particular severities.

The likely ability of glass to withstand wind forces does not remove the hazard of fracture by failure of the sash or its fixings, or by flying debris. The integrity of hinged sashes depends largely on the adequacy and durability of hinges and latches. These accessories should be robust, and preferably be of non-ferrous metal. Latches should be positive in action, and engage metal to metal. Fasteners or bolts that might normally engaged in slots or holes in timber members would better engage in metal striking plates secured to the timber frames or beads.

Storm shutters provided for the protection of windows are usually designed to withstand wind forces of not less than 30 lb. per sq. ft., exerted either as an external positive pressure or as a suction effect.

Louvres and doors

Matters that warrant attention in relation to windows apply to louvres also. Doors must be robust, well fitting, and well secured. Bolts or bars might be considered to relieve door hinges and latches of much of the load imposed by winds of exceptional strength

Maintenance

High humidity, and consequently corrosion, are characteristic of regions subjected to gale-force winds. Attention should therefore be given regularly to the conditions of roof claddings, gutters and downpipes and their fixings, and to the condition of ties, hinges, latches, and other important fixing devices.

Structural timber and timber into which fixings are made likewise be regardly inspected, to ensure that rot has not reduced the strength of members, or that rust has not weakened the holding power of nails, screws, or bolts. Attention should also be given to fascia boards and the linings to eaves soffits.

Existing buildings

Some of the broad recommendations made in this Note can be implemented in existing buildings as a matter of good insurance where local practices have at times proved inadequate. Roofs are particularly prone to wind damage, and they might therefore be given priority. More generally, deterioration of fixings over a period of time is likely to occur unnoticed. An annual inspection of buildings prior to the onset of the gale season is to be recommended.

Conclusions

Local practices to counter wind damage differ considerably on a regional basis, in recognition of the differing storm intensities that are encountered over widely separated areas. The need to modify particular practices in conformity with the dictates of local topography may not be so well understood. The importance of this latter matter can be gauged from the range of wind pressures included in the table given above.

The uncertainty of the wind pressures that buildings will be called upon to resist and the indeterminate strength of framed structures with nailed joints, preclude the making of firm recommendations in a generalized statement of the present character. The text is intended rather to be a reminder on wind action on buildings for the guidance of people who might be prompted by local wind damage to consider the safety of their own premises, and of those who must design for wind conditions in excess of their immediate experience.

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ADDRESSES OF CHAIRMEN AT THE ANNUAL GENERAL MEETINGS OF THE LOCAL CENTRES

Rajasthan Centre

Chairman's address by Shri B. D. Satsangi, M.I.E., at the 7th Annual General Meeting of the Centre on February 11, 1966

After welcoming the Chief Guest, Honourable Dr. K. L. Rao, Minister of Irrigation and Power, Government of India, and other invitees, Shri Satsangi thanked the Committee of the Centre for electing him Chairman for 1966-67.

Delivering the Chairman's address, he said, 'The membership of the Centre now stands at 1948 as compared with the figure 487 at the time of its establishment in 1959. The construction of building of the Centre is about to commence which will provide facilities to members consistent with their multifarious requirements.

The political, the industrial and the socialistic balance has been very much upset and the repercussion have been felt on our plan activities. We, therefore, have to bring about drastic change in our outlook. A few important factors, which require immediate readjustments to create an atmosphere conducive to bring out the maximum of the effort on the part of engineers, are proposed as under:

Achievement of plans

The Government have been striving hard, through the implementation of the plans, to develop the country's economy and improve the lot of the common man. The First Plan increased the national income by 11% and food production by 20%. The Second Plan then gave much impetus to the development of the basic industries, provided employment opportunities, and aimed at reduction of inequalities of income and wealth and more even distribution of economic power. The Third Plan laid full emphasis on various industries and the development of water resources for the generation of electric power, irrigation, highways, transport and communication, public health and community development followed in the wake.

Practical difficulties of engineers

As a major portion of the expenditure of Plans has been made on the engineering projects, the engineer is particularly responsible for achieving the targets. The engineer feels most embarrassed at his helplessness wherein he finds that for causes beyond his control, he cannot do much to make up the deficiencies. An engineer is a key figure in the total strength of industrial developments. For the best utilization of his talent and ability, therefore, it is essential to ensure in the system that by the time an engineer reaches a senior position, he is promoted to the managerial or the administrative post. He is the person most suited to control and guide the engineering side of the plan activities, and he alone realises the urgency and importance of the work, and may take firm decisions consistent with the limitations and the capacity of men and materials.

In the present age of science and technology, a much more broad outlook is necessary to achieve the results of a planned development in a country, and the engineers being most concerned with its execution, must be given a full scope of demonstrating the ability to contribute the best towards the achievement of the target. There are instances of completion of works much ahead of time and with utmost economy in cost and working man-hours, where the public or private establishments have placed full confidence in the engineer's ability, and have invested him with the requisite administrative and executive control. It can be hoped that through the good offices of our Education Minister, the policy of giving the engineers an appropriate hand in the administrative control at appropriate levels will be developed.

Disparity between State and the Central Services

The disparity between the State and the Central Services is also agitating the minds of engineering personnel. The Central Government has taken steps to establish the All-India Service of Engineers, and in this context, it devolves upon the State Government to bring the service provisions at par with those of the Central Services.

Fall in standard of technical education

Besides these two major factors, the question of proper training of engineers, technicians and skilled labour is assuming great importance. The position as it exists in engineering and technical institutions today, is well known to every one of us, and it is no wonder to find that standards at the graduate and diploma levels have fallen low. As a man of tomorrow, an engineer should not only acquire the competence in his field, but should also have intelligent coverage in many other allied fields of knowledge. There is the immediate need to tackle this problem on priority basis as it is on the success of finding proper remedies that the fulfilment of the requirements of the manpower for the plans mostly depends. The products of engineering colleges should undergo a regular and planned apprenticeship and training. The scientific and technical advancements are coming so fast that the need for continuing one's education is far greater now than ever before. Special provisions for in-service training should therefore be made in the service rules.

Utilization of consultative service and need for technological centres

Another important source of technical know-how that has not been utilized so far is the consultative services that could be rendered by the public and private professional bodies. To continue the dependence on foreign consultants and collaborators in the fields where our own engineers have developed sufficient experience and are confident to take up this work, it will be suicidal to deprive them of their initiative, which they have taken to extricate the country from the foreign collaboration.

Besides 23 national laboratories, the small and large industries of the country need such practical type of technological centres which could help and guide them in perfecting their process and stabilizing their production economy.

The challenge before us

While scientific and technical advancement in some countries of the world have attained dazzling heights that they are planning to land on the moon by 1970 and are working on plans to make use of the rocket propulsion in the civil aviation, our efforts are not satisfactory even to provide food and clothing to our starving countrymen. It was the sustained effort of the people themselves that the U.S.A. today is at the height of its supremacy. The history of the U.S.S.R. is equally impressive. Countries like Italy, France, Germany and Japan provide examples of bold venture.

The responsibility of employers and planning bodies in the Government lies in creating conditions and opportunities for the engineer to demonstrate his ability and willingness to contribute all that he is capable of'.

Uttar Pradesh Centre

Chairman's address by P. S. Bhatnagar, C.E., M.I.E., at the 45th Annual General Meeting of the Centre on January 9, 1966

After welcoming the Chief Guest, and other invitees, Shri P. S. Bhatnagar thanked the Committee of the Centre for electing him Chairman for 1966-67.

Delivering the Chairman's Address, he said, 'The Institution of Engineers (India) was set up by a band of devoted workers in 1920. It continued to grow in strength and usefulness, which earned for it the Royal Charter in 1935. The Institution has the unique feature of bringing together engineers of all branches to one forum, thus proving the basic unity of the engineering profession. Engineers have a vital role in the development of the country and the implementation of the Plans. The engineers of the State have achieved the targets set for them. By the end of this financial year, the lengths of roads will be 16,000 miles against 10,050 at the end of the Second Plan. Eighty bridges including those on the Ganga at Garhmukteshwar, the Ghagra at Ayodhyya and over the Jamuna at Mathura will have been added. In our bid to raise the food production a large number of irrigation projects have been completed and the length of channels will increase from 25,915 to 29,400 miles to take water to the thirsty fields. Over 1,500 tube wells have been built along with thousands of *pucca* and *kachcha* wells to augment the supply and to irrigate the area not fully served by the canals, thus increasing the irrigated area from 19 to 30%. Drainage has also received due attention to mitigate the evil effects of excessive rainfall and rise in sub-soil water level. The Committee set up by Government to assess the utility of flood and drainage works has found overwhelming praise for the benefits that have accrued A large number of hydro-electric and thermal power stations have come up to supply power for the wheels of industry raising the installed capacity over three times from 293.270 to 1,124.400 MW. Almost every village in three, has been electrified. Water supply and sewerage schemes have been completed in a large number of towns adding greatly to the health and convenience of the population. The railways have extended their electrification to Allahabad and will soon be reaching Kanpur. The day is not far ahead when the engineers will have replaced coal with electricity to make the murky atmosphere of Kanpur a thing of the past. The targets achieved in the Third Plan, however high do not touch the fringe of our requirements. Reconstruction of the existing roads to suit the present traffic would require Rs. 80 crores, and provision of the missing bridges another Rs. 160 crores. Similar large amounts are needed in other respects. It is said that U.P. which was once the foremost state of India is now trailing behind many. The progress has certainly remained restricted on account of scarcity of available resources. It is, however, worth remembering that men, material and money are not all that is required for rapid development. The psychological factor has generally not been given the recognition it deserves

In every country where development has taken long strides, the government have placed full confidence in technical personnel and have given them due recognition and authority to enable them to deliver the goods. As is well known, the engineering personnel, particularly in government service are working under a great handicap, and they cannot naturally be expected to give their best. The usual practice so far adopted is to appoint an administrator as the head with a set of technical officers drawn from various organisations. The administrators are selected for their wide administrative experience even though in quite a different field. They are undeniably able persons. But, the real problem is the ability to effectively utilize existing knowledge. This can best be done by the technicians experienced in the line and not by an outsider. Vitality and initiative are closely dependent upon the manner in which an activity is organised. With a non-technical head, the expert finds it exasperating to carry his point with a distrusting bureaucrat, and ends up with the loss of his initiative and enthusiasm. It is heartening to see that this point has been realised by our State Government, and the worthy Chief Engineer of the State Electricity Board has been appointed as the Chairman as well. I wish him and the Board all success in tackling the ever increasing complex problems. To my brother engineers I have only to request that they should forget their handicaps and devote their might to the task before the country, always keeping in mind the high ideals of the Institution.

In spite of the handicaps just mentioned, I may reiterate that the development and welfare of the country remains uppermost in the mind of every engineer, and in the activities of this Institution. A seminar is being held by all Local Centres on the 'Role of Engineers in the Fourth Plan' with special emphasis on defence and food problems, to be integrated at the time of the All-India Convention being held at Patna later this month. This Centre is organising a seminar on the burning question of 'Substitute for Cement as a Building Material', and 'Cracks in Concrete and Preventive Measures'—both of which are topics of great engineering importance as well as of great general interest'.

Summaries of Papers Published in the Journal, vol. 46, nos. CI 5, ME 5 and ET 3, May 1966

CIVIL ENGINEERING DIVISION

A Solution for the Eight-Point Problem in Surveying

Dr. K. C. Chakko

Member

Triangulation is the basis of surveying. It requires mutually visible instrument stations. In the re-section method of survey, known points are necessary. However, a method has been developed by the author in which neither the mutually visible stations nor the known points are required. This paper describes the application of the method to obtain a series of observations for the 8-point problem.

Energy Loss in a Hydraulic Jump

M. M. Dandekar

Associate Member

This paper presents a solution to the loss of energy problem in a hydraulic jump in the form of graphical curves, prepared on the basis of a rigorous equation derived using non-dimensional parameters.

Natural Roughness Effects in Rigid Open Channels

B. Suryanarayana

Non-member

This paper describes a series of experiments carried out to determine the effect of roughness spacing in open channel flow. The conditions of dunes and ripples on stream bed were created by fixing the corrugations of asbestos cement sheet, 1.85 in. in height, at various spacings, to the bed of a 3 ft. wide rigid bed flume, 62 ft. in length. The roughness elements were fixed at 6, 9, 18 and 36 in. intervals. It was observed that the Chezy's resistance function, and the relative roughness parameter, are related by a logarithm formula. It also presents the various graphs connecting the Chezy's resistance function with the other factors such as Reynolds number, Froude number, etc.

Economics and Constructional Advantages of Detour Canal Alignments

R. Satyanarayana Moorthy

Associate Member

The Nagarjunasagar Right Main Canal is one of the biggest canals in the world. With a head discharge of 21,000 cusec., it runs as a contour canal for 276 miles. The canal in its run from Krishna to Pennar crosses several hill ranges, major streams and valleys giving scope for various alternatives to be examined. The alignment as finalized and provided for in the project report crosses ridges with tunnels and deep cuts and major streams by means of aqueducts and high approach embankments. The paper deals with how adoption detour alignments has resulted in considerable savings in cost, besides facilitating construction with practically no foreign exchange required. This paper describes three typical cases to illustrate the advantages, and the design and construction aspects of the detour alignments.

Role of Hydel Generation in Chotanagpur (Bihar) with Reference to Subernarekha Hydro-Electric cum Water Supply Project

D. Narayan

Associate Member

This paper stresses the importance of hydel power generation in the Chotanagpur District of Bihar, where the existence of sufficient reserve of low grade coal and the middlings from the coal washeries has so far prompted thermal power generation only. It also describes the design aspects of Subernarekha hydro-electric cum water supply project.

Study of Drainage Behind Lining in Irrigation Channels with Special Reference to Nangal Hydel Channel

Dr. H. L. Uppal

Member

and

M. P. Singh

Non-member

After the damage in the lining of the Nangal hydel channel in 1957, it was considered necessary to study the workability of a drainage system comprising open jointed drains, continuous sand blankets, shingle filters, flap valves and weep holes laid during construction as a safeguard against the high subsoil water level in the cutting reaches. The data of subsoil water table along Nangal hydel channel from 1950-63 were collected. Day to day changes in subsoil water level in the cutting reaches corresponding to the variations in canal water level from January-June 1958, during the closure period in January 1964, and on re-opening of the canal in February 1964 were observed and examined in detail. The behaviour of canal lining during the closure period in 1963 and 1964 was also studied. This paper presents the details of the studies and the conclusions derived therefrom.

SHELL STRUCTURES GROUP

Shell Roof for Large Projects in India

B. K. Chatterjee

Associate Member

This paper analyzes the cost aspects of shell structures as compared with the structures of conventional design and recommends their wider use in the large projects in India.

A Survey of Numerical Procedures for the Analysis of Plate and Shell Problems

Dr. J. R. Desai

Non-member

The plate and shell problems present complicated differential equations. For such equations, exact mathematical solutions are not known; and hence, recourse has to be taken to the numerical methods for obtaining approximate solutions. The various methods for solving these equations which are currently in use are described in this paper.

Computer Analysis of Folded Plates by the Method of Transfer Matrices

M. Ramaiah

Associate Member

This paper presents a modification of Holand's method for the analysis of folded plates and extends it to analyze the northlight folded plate structures. It also presents a programme for analyzing a folded plate structure on an IBM 1620 digital computer using the method.

RAILWAY ENGINEERING GROUP

Some Aspects in the Design of Plate Girders for Curved Railway Tracks

R. Nagarajan

Associate Member

and

S. Krishnamurthy

Student

This paper presents a new method of design of mild steel deck type plate girders for curved railway tracks which is more economical and efficient than the existing methods of design. This involves an adjustment of the disposition of the track with respect to the centre line of girders, and enables both the outer and inner girders to carry the same bending moment under vertical loads as in the case of plate girders in straight tracks. The adjustments required in the existing design of Indian Railway Standard girders, essentially made for straight tracks, for use on curved tracks as well are also described.

ROADS AND ROAD TRANSPORTATION GROUP

Is Simpson's Rule the Best?

R. S. Karmarkar

Non-member

The Simpson's rule is based on the assumption that the outline of a figure is made up of a series of independent parabolic curves. In one case, which is not rare, Simpson's rule is not at all fool-proof and gives either too high or too low results. This paper suggests a new formula, based on the Simpson's rule, which approaches the trapezoidal form and indicates its practical applications.

Design Aspect of Prestressed Concrete Pavements

V. K. Khosla

Non-member

and

Dr. N. K. Vaswani

Associate Member

This paper describes the behaviour of prestressed concrete pavements under load and also deals with the different methods for their design Based on the existing theories and design methods, a new method has been recommended. It also presents a design problem and discusses the different factors to be considered for the design.

MECHANICAL ENGINEERING DIVISION

Development of an Optoscope for Accurate Determination of Chip Reduction Coefficient in Metal Cutting

J. Banerjee

Non-member

and

Dr. A. Bhattacharyya

Associate Member

This paper presents the results of investigations carried out for the measurement of chip reduction coefficient by the conventional micrometer method as well as by an optoscope devised at the Machine Tool Laboratory, of the Jadavpur University.

Analysis of the Rate of Deformation at the Chip-Tool Contact Zone

B. K. Mullick

Associate Member

and

Dr. A. Bhattacharyya

Associate Member

This paper presents the determination of the rate of deformation in metal cutting from a frozen chip sample obtained with a quick stop apparatus. The combined effect of distribution of temperature and rate of deformation of the chip-tool interfacial shear stress has been evaluated by the method of modified temperature.

INDUSTRIAL ENGINEERING GROUP

Effect of Machine Control and Cycle Time on Working Pace

K. Chandra Mouli

Non-member

and

Prof. N. K. Datta

Associate Member

The paper deals with the experiments conducted to find the effect of the amount of machine control and the length of cycle time on the performance of an operator. Further, it describes the results of an investigation carried out in an industrial set-up working under non-incentive conditions. The experimental results show that in addition to the percentage machine control, the length of the cycle time also has a definite effect on the pace of working. However, no such effect has been observed in the non-incentive conditions of the plant studied. Reasons for this different in the findings are discussed. Also, an attempt is made for the application of Kennelly's law to the problem of finding the maintainable pace in operations with intermittent periods of manual work.

The Assembly Line Balancing Problem

K. C. Sahu

Associate Member

In recent years, the problem of assembly line balancing has attracted the attention of many research workers. But so far, besides some theoretical models based on rather simple and unpractical assumptions, nothing substantial has been done either to make the suggested solutions computationally feasible, or to apply the solutions to practical assembly lines. Optimality is not achieved in most of the solutions proposed. This paper analyzes the problem with a view to overcome the deficiencies of the earlier solutions

Operations Research in Industrial Management

V. L. N. Row

Member

Operations research broadly involves the application of a scientific approach to industrial management problems covering a wide range. Its merit lies in its ability, after the collection of available data, to precisely define the relative merits of all courses of action open. A final decision is then taken by the management after giving due weight to each factor. This paper describes the methods of operations research and recommends its wide adoption in the Indian enterprises.

ELECTRONICS AND TELECOMMUNICATION ENGINEERING DIVISION

Waveform Analysis of E.D.A. Solutions and Determination of Describing Functions with the Vectrometer

B. N. Nityanandan

Non-member

This paper presents an experimental method for accurate analysis of waveforms representing solutions of linear and non-linear systems obtained on a repetitive differential analyzer. The method proposed is also shown to be useful for the direct evaluation of 'describing functions' for non-linear characteristics, commonly encountered in control systems. The method proposed envisages the use of a less-used instrument designed by Kopplemann (1948). The design considerations for the circuitry needed to adopt this equipment in the present case, are also discussed.

INSTITUTION NOTICES

Draft Indian Standards

The following Draft Indian Standards have been issued recently.

1. Draft Indian Standard and Safety Codes for Scaffolds and Ladders—1 : Scaffolds, and 2 : Ladders—Doc : BDC 45.

This standard lays down the safety requirements for the use of scaffolds for supporting workmen or materials for any construction work including maintenance and demolition.

Members may send their comments on the draft standard before June 1, 1966, to Prof. R. N. Dogra (*M.*), Principal, College of Engineering and Technology, New Delhi 16, who is the Institution representative on the Sectional Committee dealing with this draft Standard.

2. Draft Indian Standard Specifications for Aluminium Equal Angles for Structural Use—Doc : SMD 66 (723)

This standard lays down the dimensions of aluminium equal leg angles for structural use.

3. Draft Indian Standard Specifications for Aluminium Unequal Angles for Structural Use—Doc : SMDC 6 (724)

This standard lays down dimensions of aluminium unequal leg angles for structural use.

4. Draft Indian Standard Specifications for Aluminium Channels for Structural Use—Doc : SMDC 6 (739)

This standard lays down the dimensions of structural aluminium channels.

5. Draft Indian Standard Specifications for Rolled Steel Products (First Revision of I.S. : 1852-1962)—Doc : SMDC 6 (768)

This standard lays down rolling and cutting tolerances for hot rolled structural steel beams, channels, equal and unequal angles, tee bars, bulb angles, angles with legs of unequal width and thickness, round and square bars (other than bars meant for fasteners), flats, plates, strips and sheets.

Members may send their comments on these draft Standards before July 1, 1966, to Shri T. R. Mehandru (*M*), 14 Asaf Ali Road, Ajmeri Gate Extension, New Delhi, who is the Institution representative on the Committee dealing with these draft standards and a copy to Shri K. K. Nambiar (*M*), Chairman, Civil Engineering Division, Chief Engineer, Concrete Association of India, 121 Queens Road, Bombay 1.

Copies of the draft Standards may be obtained from the office of Indian Standards Institution, 'Manak Bhavan', 9 Bahadur Shah Zafar Marg, New Delhi 1, or from its branch offices at Bombay Mutual Terrace, Sandhurst Bridge, Bombay 7; 5 Chowringhee Approach, Calcutta 13; 14/69 Civil Lines, Kanpur ; or 54 General Patters Road, Madras 2.

Misdemeanour in the Institution examinations

The Council have decided to cancel the results of the following candidates for the November 1965 examinations and debar them from appearing in the Institution examinations up to and including that mentioned against each name.

Name	Studentship No.	Roll No.	Debarred up to and including
Rabindra Mohan Sen	S 39796	4279NA	November 1966
Jai Krishan Garg	S 59631	4400NA	November 1966
Shyam Mohan Lal	S 61260	5650NA	November 1966
G. P. Sharma	S 47637	6129NA	November 1966
P. R. Sharma	S 54990	6130NA	November 1966
S. K. Shukla	S 61214	5831NA	November 1966
S. C. Jain	S 61097	5832NA	November 1966
Rama Kant Arya	S 25850	750NB	November 1966
Bihari Lal Gupta	S 31224	1065NB	November 1966
Biswanath Chatterjee	S 31260	2644NB	November 1966
K. L. Khanna	52198-S	257ST	May 1967
Ram Prasad Sinha	S 63057	1643A	May 1967
Satyanarayan Sinha	S 34302	2046NA	May 1967
Prem Kumar Bajaj	S 56741	2799NA	May 1967
R. K. Mohindro	S 41094	7375NA	May 1967
G. Dora	S 33835	325NB	May 1967

Visit of the President and the Secretary of the Institution of Electrical Engineers, London

Mr. L. Drucquer, President, and Dr. G. F. Gainsborough, Secretary, of the Institution of Electrical Engineers, London, visited this country from April 7 to 27, 1966. During their stay in India, they addressed a meeting of the Mysore Centre of the Institution held in Bangalore on April 8, 1966, and proceeded to Madras. After spending three days in Madras, they arrived in Calcutta on April 13. They addressed a joint meeting of the members of the Bengal Centre of the Institution and the oversea members of the Institution of Electrical Engineers, London. At this meeting, Mr. Drucquer spoke on the status of the engineering profession in the U.K. with particular reference to electrical engineering and Dr. Gainsborough described the activities of the Institution of Electrical Engineers, London. This was followed by a brief report by Prof. H. C. Guha (*M.*), Chairman, Electrical Engineering Division, giving the functions of the Electrical Engineering Division of the Institution. The itinerary of Mr. Drucquer and Dr. Gainsborough included visits to Delhi, Bhopal and Bombay.

Brief biographical notes about them are given below.

Mr. Leonard Drucquer, Divisional Director and General Manager, Heavy Plant Division, Associated Electrical Industries Ltd., was educated at Haberdashers Askes, London, and London Polytechnic Engineering College. He joined the staff of the British Thomson-Houston Co. Ltd. in 1920 and until 1938 worked in outside construction and contract engineering. He was appointed Assistant Manager, Switchgear Sales, in 1938 and was Manager from 1945-50. He was Manager, Home Sales (Plant and Apparatus) from 1950-56, Director and Manager, Home Sales, from 1956-58, and was appointed to his present position of Divisional Director and General Manager, Heavy Plant Division, Associated Electrical Industries Ltd., in 1958.

Mr. Drucquer is also Chairman, A.E.I. Divisional Management Co. Ltd., Director, E. R. A. Patents Ltd., and Director, A. E. I. Automation Ltd. He is a member of the Governing Body of the Rugby College of Engineering Technology, the Industrial Electrical Machinery Board of BEAMA, the Institute of Directors, and the Iron and Steel Institute.

Mr. Drucquer was Chairman of the supply section of the Institution of Electrical Engineers in 1955-56. He became Vice-President of the I.E.E. in 1962 and was elected President for the session 1965-66 in October 1965.

Dr. G. F. Gainsborough, was educated at Christ's Hospital and King's College, London, where he took his degree in Physics. He is a Barrister-at-Law of Gray's Inn.

After service in the Physics Department of King's College, he joined the Radio Division of the National Physical Laboratory and in 1944-45 was sent to the British Commonwealth Scientific Office in Washington. Shortly after his return to England, he was transferred to the Administrative Civil Service, and was attached to the Ministry of Supply, and later to the Ministry of Aviation. In 1960 he spent a year at the Imperial Defence College He took up his appointment as Secretary of the Institution of Electrical Engineers in succession to Mr. W. K. Brasher from October 1962.

LOCAL CENTRE ACTIVITIES

Bhopal Sub-Centre

The second Annual General Meeting of the Bhopal Sub-Centre of the Institution was held on March 14, 1966. Dr. S. D. Sharma, Industries Minister, Madhya Pradesh, was the Chief Guest. The Chief Guest in his inaugural address explained the experience gained in the last Indo-Pakistan conflict when India found herself helpless in many respects on account of her dependence on foreign nations for many essential items. Dr. Sharma, therefore, stressed the essentiality to develop indigenous industries to make the all-round self-sufficiency hundred percent. Dr. Sharma called upon the young engineers of the Heavy Electricals Ltd., to lead research and development, and hoped the Institution of Engineers to enthuse the requisite spirit. While on the development of heavy electricals industries in Madhya Pradesh, Dr. Sharma disclosed that the State Government would be pleased to have the advice of a consultancy bureau, set up by the Heavy Electricals Ltd., Bhopal, wherein the Institution can take a leading role to aid the development of smaller units. Substitution not only of components and raw materials, but that of talented skill is also essential for the prosperity of the Nation and the minister hoped that the Institution will play a vital role in this.

Shri S. Swaymbu, Director (Technical) and Chief Engineer of Heavy Electricals Ltd. and Chairman of the Sub-Centre explained in brief the power potentialities of India and our plans to exploit them fully by the end of the Sixth Plan.

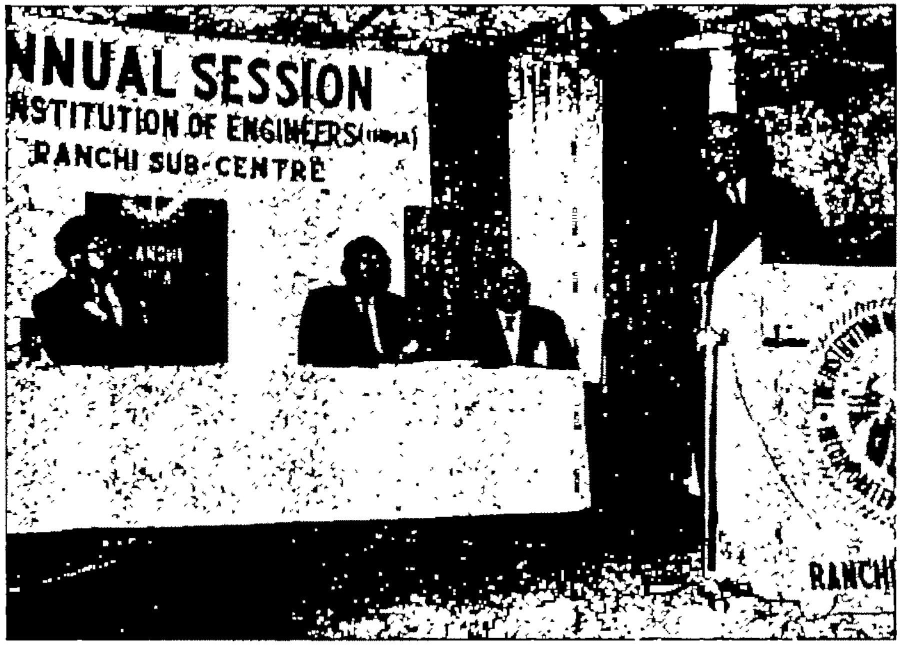
Shri R. Krishnamurthy, Honorary Secretary of the Sub-Centre proposed a vote of thanks to the Chief Guest and other invitees, and the meeting came to an end.

The guests who attended the function included Shri K C. Lal, Chairman and Managing Director, Heavy Electricals (India) Ltd., Mr. John Dyson, Resident Consultant, Associated Electricals Industries Ltd., Shri Sood. irrigation Adviser to the Government, and Shri Karnad, Deputy Chief Engineer, Madhya Pradesh Electricity Board

Ranchi Sub-Centre

The Fifth Annual General Meeting of the Ranchi Sub-Centre was held at the Rotary Hall, Ranchi, on January 24, 1966. Shri S. T. Raja, Managing Director, National Coal Development Corporation, was the Chief Guest. In his Chairman's address Shri M. B. Tawadey said, 'Bihar is a State full of mineral resources, especially, coal and iron-ore. Today, Bihar produces 58% of the total coal, and 75% of metallurgical coal, very essential for the steel industry.

In this age of science and technology, the engineers and scientists constitute the main spearhead of economic advance as also for defence. In large engineering enterprises, the key men should therefore be the engineers. In some quarters, however, there is sometimes mental reservation to place engineers at the helm of affairs, and give him the place for which he has received his education and training. The targedy, if I may say so, is that such hesitations are motivated by considerations other than technical. These complexes are dying out but the sooner such things are weeded out, the better it will be for our country. Today we are faced with enormous problem. On one hand, we, engineers, have to maintain and repair equipment imported from abroad, and on the other hand manufacture new equipment for our developing industries. Spares required for maintenance of the equipment could undoubtedly be manufactured, as we have the necessary machine capacity. Import substitution has become a vital necessity, and it is here that the resourcefulness of engineers is called for. To my mind, the engineer would be today failing in his professional duty if he merely hibernates awaiting receipt of imported spares to keep his equipment in action'.



SHRI S. T. RAJA, CHIEF GUEST, INAUGURATING THE MEETING

The Chief Guest, in his inaugural address, said, 'Engineers have already played a great role in national construction and development. In future also, the prosperity and development of this country are going to depend upon the manner in which they discharge their duties. In our country, engineers have not received full recognition that they deserve as compared to various other countries like the U.S.A., the U.S.S.R., etc., but things are changing very rapidly and the time will not be far off when full recognition will be given to the engineers in the task of national reconstruction.

In agriculture, industry and social services we have invested large funds but the actual achievements fall far short of expectations and needs. Our planners, engineers and administrators have now to make much greater efforts as a team so that the country makes more rapid progress than made hitherto. Money is only a measure of payment; but real production of wealth depends upon the productive efforts of men properly organized, and motivated with a sense of purpose and discipline. Our development is not, therefore, so much a question of money and resources as of the manner in which we deploy our human resources, organize them, motivate them and make them realize that they are all working for the good of the country. The engineers being the builders of the Nation and intimately connected with all these developmental activities, have a great role to play in this national endeavour. On this occasion, I extend to you and your Sub-Centre my heartiest congratulations and good wishes that you may have the privilege of building a great country which will be a model of freedom and prosperity and a bastion of peace in the world'.

Shri S. K. Sharma, Honorary Secretary of the Sub-Centre, then proposed a vote of thanks to the Chief Guest and other invitees and the meeting ended.

FORTHCOMING EVENTS

Refresher and specialist courses in engineering subjects at the University of Roorkee, Roorkee

The following refresher and specialist courses will be conducted by the University of Roorkee during the periods mentioned against each.

Refresher Course in Electrical Engineering	June 1-August 31, 1966
Specialist Courses	
Tunnels and Underground Excavation	May 30-June 18, 1966
Steel Foundry Practice	July 11-August 1, 1965
Erection, Commissioning and Maintenance of Hydro-Electric Power and Steam Stations	September 1-28, 1968
Air Conditioning and Regrigeration	July 1-29, 1966
Foundation Engineering	July 12-August 30, 1966
System Protection	August 2-31, 1966

An admission fee of Rs. 50 and tuition fee of Rs. 75 per month or part thereof will be charged. Further details can be had from the Director, Refresher Courses, University of Roorkee, Roorkee.

'Choose Your Career' campaign of the Delhi Administration, June 10-17, 1966

The Directorate of Employment, Training and Technical Education of the Delhi Administration is planning to organize a 'Choose your Career' campaign in six centres in Delhi from June 10 to 17, 1966. The second of its kind, the campaign is expected to be inaugurated by the Union Minister for Labour and Employment and will be visited by several hundreds of students, parents, teachers, councillors and career masters. These centres will furnish the visitors with career guidance; educational councelling and occupational information, etc.

Symposium on 'Site Investigation for Foundations', Roorkee, February, 1967

A Symposium on 'Site Investigation for Foundations' will be held for three days at the Central Building Research Institute, Roorkee, in February 1967 The symposium will deal with the following subjects:

i) Organization, planning and economics of site investigations;

(ii) Methods and extent of investigation (aerial survey and mapping; geological and geophysical exploration, boring techniques, sampling techniques);

(iii) *In-situ* tests (load tests, penetration tests, field vane shear tests, and *in-situ* moisture density measurements);

(iv) Special site investigations for specific purpose (roads and runways, embankments, machine foundations, nuclear power installations, rocket sites, etc.).

Contribution of papers on the above topics are invited. Summaries of papers, not exceeding 300 words, should be sent to the Institute before June 31, 1966, and the full paper by the end of August 1966.

Further details may be had from Shri P. L. De, General Secretary (Symposium), Central Building Research Institute, Roorkee, Uttar Pradesh

Symposium on 'Organization and Management of Design and Development', Enfield, July 4, 1966

A one-day Symposium on 'The Organization and Management of Design and Development' will be held at Enfield, Middlesex, U.K., on July 4, 1966 Organized by the Enfield College of Technology, the Symposium will discuss critically and in detail the problems of making design methods with particular reference to laboratory-type design work. Prominent people from industry will present papers on (i) Scheduling and Budgetary Control; (ii) Environment and Control of Creativity; (iii) Delegation and Initiative; (iv) Techniques for Effective Utilization of Men and Equipment; and (v) Structure of Research and Development Departments.

Further details can be obtained from The Academic Registrar, (Design Symposium), Queensway, Enfield, Middlesex, U.K.

Sixth International Conference on Microwave and Optical Generation and Amplification, Cambridge University, September 12-16, 1966

The Sixth International Conference on Microwave and Optical Generation and Amplification will be held at the Cambridge University from September 12 to 16, 1966 Sponsored by the Electronics Division of the Institution of

Electrical Engineers, the aim of the Conference is to stimulate the exchange of ideas on the research which will have taken place (since the Fifth Conference in Paris in September 1964) in the fields of microwave and optical generation, amplification and other active processes. Contributions on recent, outstanding scientific and technical progress in these fields will be presented and discussed. The programme will cover microwave and optical generation by solid state, plasma and other active devices, as well as the classical forms of microwave tubes. In addition, it will include the application of various principles and phenomena relevant to the generation and amplification of coherent electro-magnetic waves without strict frequency limitation.

Further particulars can be obtained from The Joint Conference Secretariat, The Institution of Electrical Engineers, Savoy Place, London, W C 2

International Conference on Automatic Operation and Control of Broadcasting Equipment, London, November 9-11, 1966

An international conference on the automatic operation and control of broadcasting equipment will be held at the Institution of Electrical Engineers, London, from November 9-11, 1966. The meeting is sponsored jointly by the Television Groups of the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers, the Television Society and the Institute of Electrical and Electronics Engineers. Contributions are invited for inclusion in the programme. The conference will cover all aspects of the automatic operation and control of broadcasting equipment including: (i) Programme distribution systems; (ii) Picture and sound generation equipment including automatic lighting control; (iii) Switching and distribution equipment; (iv) Communication equipment; (v) Primary and relay transmitting equipment; and (vi) Monitoring equipment.

Further details can be obtained from the Conference Secretariat, The Institution of Electrical Engineers, Savoy Place, London, W.C. 2.

Deutscher Betontag 1867, Berlin, April 5-7, 1967

The Deutscher Beton-Verein E.V., the German Member Group of the F.I.P., are arranging to hold 'Deutscher Betontag 1867' from April 5 to 7, 1967, in Berlin.

Further particulars can be obtained from Deutscher Beton-Verein E.V, 62 Wiesbaden, P.O. Box 543, West Germany.

IFAC Symposium on 'The Problems of Identification in Automatic Control Systems', Prague, June 1967

The Institute of Information Theory and Automation of the Czechoslovak Academy of Science will hold an International Symposium on 'The Problems of Identification in Automatic Control Systems' in Prague, Czechoslovakia, in June 1967. To be held under the auspices of the International Federation of Automatic Control (IFAC), the aim of the Symposium is to show the world-wide state of the given field and present time trends in its development, to allow exchange of experiences, and to establish new personal contacts among specialists in this field. Papers intended for presentation at the Symposium should deal with the following topics:

1. General problems of the identification of dynamic systems (general problems of the mathematical description of dynamic properties of linear and non-linear objects, new approaches to the problem of identification, approximations of dynamic characteristics, etc.).
2. Calculations of the dynamic characteristics of physical systems by means of mathematical-physical analysis (new results of the theoretical analysis of dynamic objects, results of experiments verifying theories known to date).
3. Statistical methods of the experimental identification of continuous and discrete systems (correlation and regression analyses, identification of multiparameter systems and systems with feed-back and inner noise, statistical estimation of unknown parameters, practical experience gained from the application of statistical methods).
4. Methods of experimental identification, based on the evaluation of responses to determined input signals (frequency methods, approximation of frequency characteristics, evaluation of responses to non-periodic input signals).
5. Determination of the dynamic characteristics of the systems by means of adaptive models (permament and one-at-a-time identification, problems of the optimum strategy of adaptation, new principles and schemes of adaptive models).
6. Special instruments for the identification of systems and signals (new designs of correlators, generators of nonperiodic signals, generators of stochastic signals, special apparatus for the statistical evaluation of measured signals, etc.).

The Institution of Engineers (India) is the National Member Organization of the IFAC and further details of the Symposium can be obtained from the Assistant Secretary (Technical) at the Headquarters Office.

Award of prizes by the International Institute of Refrigeration, Paris

The International Institute of Refrigeration has decided to award a number of prizes at the 12th International Congress of Refrigeration to be held in Madrid in 1967. These will be in recognition of original studies of outstanding merit, capable of leading to progress in the science and technology of refrigeration, and which can be presented at the Congress. Each prize shall be of the value of 2,000 FF (about £145 or $400).

Further details can be obtained from the International Institute of Refrigeration, 177 Boulevard Malesherbes, Paris (17E).

BOOK ACKNOWLEDGMENTS

1. **A Library Guide to Engineering.** K. W. Neal. *Crane and Son (Printers) Ltd.*, England, 3s. 1965, 22 pages.

This booklet is intended to provide engineering students with a brief guide to the world of books and periodicals in so far as these are available in libraries.

2. **Curve Tables for Road, Railways and Irrigation.** Y. D. Kumar. *Tech. India Publications,* New Delhi, Rs. 4, 2nd edition, 46 pages.

In this book, meant for civil engineering diploma and degree students, surveyors and engineers, the author has worked out lengths of curves corresponding to radii varying from 1 to 6,000 ft. It includes tables of lengths of tangents, radii of curves, chords and offsets to suit different data necessary in preparation of projects of roads, railways, canals, and in setting out curves of various degrees. A few examples illustrating the use of the tables, and a set of other useful information for laying out curves are added. A number of standards and latest practice have been incorporated in the form of appendices.

3. **Civil Engineering Construction.** J. M. Antill and P. W. S. Ryan. *Angus and Robertson,* Sydney. £7 5s., 2nd edition, 1965, 631 pages.

This reference book for construction and design engineers deals with the problems of construction and explains the functions of plant, labour, materials, planning and organization in solving such problems. The authors in this edition have revised the text in accordance with recent developments in the various fields of civil engineering construction.

4. **Handbook of Statistics.** Published by Indian Engineering Association, Calcutta, Rs. 15, 3rd edition, 1965, 320 pages.

This handbook gives statistical information which may be of interest to the management and the executive staff in engineering firms. Most of the material has been drawn from publications issued by government and other bodies, and attempt has been made to put together the relevant material from a variety of sources in a compact form.

5. **A Guide to Governmental Procurement Techniques.** L. G. Harvey. *Intercontinental Publications, Inc.,* $3.5, 1965, 89 pages.

This handbook is designed especially for public administrators who are charged with responsibilities of purchasing and other operations. Although, the procurement law and practice differ from country to country, this volume for ready reference to the procurement practices accepted by modern governments, however, will provide many suggestions of value to the reader. Besides, a summary of principles of government procurement, features like sample forms and advertisement section have been included.

6. **Ordinary Differential and Difference Equations.** F. Chorlton. *D. Van Nostrand Co., Inc.,* $8.50, 1965, 281 pages.

This book intended to meet the needs of science and engineering undergraduates aims to develop the elements of ordinary differential and difference equations, and illustrates their application in various branches of science and engineering. The text contains numerous examples, solved and unsolved, from such diverse fields as geometry, mechanics, physics, chemistry and engineering.

7. **Electricity and Magnetism—vol. 2.** E. M. Purcell. *McGraw-Hill Book Co.,* 1965, 459 pages.

This book covering two year college physics course for the students majoring in science and engineering has been written to present elementary physics, as far as possible in the way it is used by physicists working on the forefront of their field. Emphasis is laid on the nature of atomic and molecular dipoles.

8. **Principles of Physics.** F. Bueche. *McGraw-Hill Book Co., Inc.*, 1965, 660 pages.

This elementary text-book provides the basic knowledge of the different forms of energy such as heat, light, sound and electro-magnetic energy. All electrical quantities are handled in the practical M.K.S. system of units.

9. **Elementary Coordinate Geometry of Two Dimensions.** N. Vencoba Row. *Swastika Printing Works*, Bangalore, Rs. 3, 1965, 159 pages.

This elementary text-book is intended to cover the syllabus of the degree standard in a number of Indian universities.

10. **Fundamental Analogue Techniques.** R. J. A. Paul. *Blackie and Son Ltd.*, 35s. 1965, 216 pages.

The book enables the engineers and applied scientists, for whom the electronic analogue computer is an everyday tool, to understand the basic principles of analogue computing techniques. A detailed treatment of the electronic machine is given and programming, scaling and checking are considered. The differential analyser is discussed, the study of systems by dynamic analysis is explained, and the iterative operation of analogue computers is described.

11. **Railway Engineering.** S. C. Rangwala. *Charotar Book Stall*, Anand, Rs. 10, 2nd edition, 1965, 296 pages.

This revised and enlarged second edition of the book aims at presenting the fundamental principles of Railway Engineering and is useful to all students preparing either for degree or diploma courses. The text of the book is according to prevailing Indian practice and the essential information about Indian Railways is also included. The metric units are given side by side with the British units.

12. **Reinforced Concrete.** K. L. Rao, *Charotar Book Stall*, Anand, Rs. 17.50, 4th edition, 1965, 592 pages.

The book is the result of experience of the author in the field of construction, design, and teaching over a period of more than 30 years. The fundamentals of theory, testing and design of reinforced concrete are presented. It aims at equipping the student for design and execution of reinforced concrete works. Problems in the book have been taken from the recent examination papers of the universities of London, Birmingham, and also from those of the Institutions of Civil and Structural Engineers.

PUBLICATIONS RECEIVED

A copy of the publication entitled 'Symposium on Steam Power Station'—Papers and Addresses, vol. 1, Rs. 90.00, 1965, 1,000 pages, has been received from the Indian Journal of Power and River Development, 6/2 Madan Street, Calcutta 13. The publication contains addresses and 97 papers presented at the International Symposium held at New Delhi in January 1965. More than eighty foreign experts including those from the U.S.A., U.K., Canada, West Germany, France, Belgium, Switzerland, Poland, Czechoslovakia, and Japan; and about two hundred and fifty Indian experts had attended. The Symposium dealt with the latest concepts in regard to thermal efficiency of the turbine, generating plant, the coal handling and ash disposal systems, the treatment of water for boiler feed, planning and construction of large power stations, new methods of reducing exhaust losses, improvements in blading efficiency, low cost of generation, new materials to resist high temperatures, high level of inspection with the application of modern techniques, etc. The papers in this volume have been published under appropriate heads, viz., (i) The steam power field, (ii) The steam cycle, (iii) Steam generators, (iv) Turbo-generators, (v) Electrical auxiliaries, (vi) Boiler feed pumps and piping, (vii) Heat exchange, (viii) Instrumentation and control, (ix) Civil engineering and architecture, (x) Managing the plant—construction and operation.

A copy of the publication no. 18, 1962 B.S. 153, entitled 'Steel Girder Bridges' has been received from British Constructional Steelwork Association, Artillery House, Westminster, London S.W. 1. The publication contains notes on the use of B.S. 153 : 3A (Loading) 1954 and parts 3B and 4 (permissible stresses, design and construction) 1958 including amendments for steel girder bridges.

A copy of B.C.S.A. publication no. 19, 1963, entitled 'Deflection of Portal Frames' has been received from British Constructional Steelwork Association, Artillery House, Westminster, London S.W. 1. It contains twelve solved examples on deflection of steel portal frames with a fixed base, transverse deflection, deflection with all bases hinged, and the deflection of three-hinged portal frames.

A copy of B.C.S.A. publication no. 20, 1963, entitled 'Modern Design of Steel Frames for Multi-Storeyed Buildings' has been received from British Constructional Steelwork Association, Artillery House, Westminster, London S.W. 1. It gives some of the recent developments in economical design and construction of steel frames for multi-small storey buildings. The five main factors, viz., high yield stress steel, universal sections, modern methods of fabrication and erection, lightweight fire protection of steelwork, and new method of analysis of framework, which can materially affect the structures of this nature, have been discussed.

A copy of B.C.S.A. publication no. 21, 1963, entitled 'Plastic Design in Steel to B.S. 968' has been received from British Constructional Steelwork Association, Artillery House, Westminster, London S.W. 1. The report explains the application of 'plastic method of design' to the portal frames of steel conforming to B.S. 968 : 1962. It includes the design examples and the experimental works done in this field.

A copy of B.C.S.A. publication no. 22, 1963, entitled 'Examples of the Design of Steel Girder Bridges' has been received from British Constructional Steelwork Association, Artillery House, Westminster, London S.W. 1. This publication deals with the design of highway bridges in accordance with B.S. 153 : part 3A (Loading) 1954, and parts 3B and 4 (Permissible stresses, and design and construction), 1958 including amendments for steel girder bridges.

A copy of B.C.S.A. publication no. 23, 1964, entitled 'The Plastic Designs of Columns' has been received from British Constructional Steelwork Association, Artillery House, Westminster, London S.W. 1. The publication gives the portal frame designer the formulae and curves for universal sections which enable an engineer to check the stability of columns in steel conforming to B.S. 968 as well as B.S. 15.

A copy of B.C.S.A. publication no. M1, 1963, entitled 'Details of Single-Storey Portal Frame Sheds' has been received from British Constructional Steelwork Association, Artillery House, Westminster, London S.W. 1. This brochure provides the engineers and architects with the particulars of single-storey pin-based portal frame sheds designed elastically in accordance with B.S. 449 : 1959.

A copy of B.C.S.A. publication no. 25, 1965, entitled 'Composite Construction for Steel Framed Buildings has been received from British Constructional Steelwork Association, Artillery House, Westminster, London S.W. 1. The object of this brochure is to present, for the assistance of the designer, up-to-date data for a comprehensive range of composite sections.

A copy of B.C.S.A. publication no. 26, 1965, entitled 'High Strength Friction Grip Bolts' has been received from British Constructional Steelwork Association, Artillery House, Westminster, London S.W. 1. Although, the scope of this brochure is mainly limited to general grade bolt associated with B.S. 3139 : part 1 : 1959 and B.S. 3294 : part 1 : 1960 ; the sufficient information has been incorporated to enable readers to prepare their own specifications for the use of higher grade bolts.

INSTITUTION NEWS

The President's itinerary

In the month of April 1966, the President, Shri B. P. Kapadia, visited various parts of India, and finally left Bombay on April 21, for Darjeeling *via* Calcutta. He dealt with some official matters when he met the Secretary and the Deputy Secretary at the Dum Dum Air Port.

On his way back from Darjeeling he attended to some important matters of the Institution on April 27, and left Calcutta for Ootacamund, on April 28 to attend the 445th Meeting of the Council held there on April 29, 1966. He stopped in Ootacamund till May 1, 1966, in order to attend various other meetings held alongside. The President left Ootacamund on the morning of May 2, 1966, to emplane at Coimbatore for Bombay, but owing to foul weather he had to put up in Coimbatore till May 3, 1966.

The President left India on May 6, 1966, for the U.K. to attend to Sixth Meeting of the Conference of the Engineering Institutions of the British Commonwealth to be held in London during May 9-20, 1966, of which the Institution is a Founder-Member. He will be joined there by Shri R. N. Banerjee, the Secretary of the Institution.

OBITUARY

The sympathy of the Institution is extended to the relatives of those whose passing is recorded here.

Raisaheb S. C. Ghosh

Raisaheb Sailesh Chandra Ghosh, M.I.E., died on December 9, 1965 at the age of 58.

Shri Ghosh studied Electrical Engineering at Birmingham and Manchester Technical Institute during 1925-28, and completed his apprenticeship at Witton and Mirrlees, Bickerton & Day Ltd. in 1929. He then came to India and during 1929-31 he was responsible for erection of Benaras Water Works, Asansol Water Works, Electric Drives of Dunbar Cotton Mills, Rewa Power House and Balrampur Power House. During 1931-32, Shri Ghosh served as Superintendent, Power House, Balrampur Estate Electric Installation, where he was in charge of erection and installation of water works, works of H.T. main, H.T. switchgears, transformers, L.T. switchgears, and two electrically driven centrifugal pumps. In 1932-51, he joined Messrs. Octavius Steel and worked in different capacities, such as, Station Superintendent, Balrampur Power House; Station Superintendent and Mains Engineer for Dacca Electric Supply Co. Ltd.; Mains Superintendent for Patna Electric Supply Co. Ltd.; and Resident Engineer and Manager, Dacca Electric Supply Co. Ltd. In 1951-58, he worked with the Damodar Valley Corporation as Superintendent, Bokaro Thermal Power Station and also as a Senior Superintending Engineer, and then was promoted to the post of Deputy Chief Electrical Engineer in 1957. From 1958, he was associated as a Chief Engineer to Sijua Electric Supply Co. Ltd. The then Government of India had conferred on him the title of Rai Saheb in recognition to his services. He was elected the Member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the Institution of Engineers, Pakistan, in 1951, 1952 and 1958 respectively.

Shri Sailesh Chandra Ghosh joined the Institution as a Member in 1962 and was an active participant in the Institution activities.

Shri M. P. Mathew

Shri Muttathottil Pailo Mathew, B.Sc. (Engg.), M.Sc. (M.E.), A.AE.S.I., M.I.E., died on March 2, 1966.

Born on March 21, 1917 at Parur, Kerala, Shri Mathew obtained his B.Sc. (Engg.) degree in Electrical and Mechanical Engineering from Benaras Hindu University in 1940. He completed his apprenticeship in 'Power and Light', Bangalore, and in the power house, Trivandrum. In the latter case he worked on diesel engines and design section of the power house. In 1941, he joined the Engineering College, Trivandrum, as a lecturer in mechanical Engineering in a second grade but was subsequently promoted as a first grade lecturer. He delivered lectures to the engineering degree and diploma students, and was associate with the mechanical engineering laboratories. In 1944, he was sent by the University of Kerala to the airfield stations in Poona and Secunderabad where he had a month's training on various types of aircrafts and aero-engines, and was on the staff of the Indian Air Training Centre, Travancore. On May 6, 1944, he was granted a commission in the Royal Indian Air Force and was given the rank of Flying Officer. From March 1946 to June 1958, he served as Assistant Professor in the Mechanical Engineering Department of the University of Kerala. In 1948, he was elected Associate of the Aeronautical Society of India. In August 1956, he went to Queen's University, Kingston, Canada where he did part-time teaching in the university and received the M.Sc. (Engg.) degree in mechanical engineering with specialization in applied thermodynamics. In June 1958, Shri Mathew was appointed Professor and Head of the Department of Mechanical Engineering at the College of Engineering, Trichur, Kerala and from 1961 he was serving in a similar capacity, at the college of Engineering, Trivandrum, Kerala

Shri Mathew joined the Institution as an Associate Member in 1947, and was transferred to full membership in 1962. He was the Member of the Executive Committee of the Kerala Centre for a number of years, and was also the Chairman of the Student Chapter for some time.

Shri B. K. Oke

Shri Bhaskar Kashinath Oke, B.E., M.I.E., died in March 1965.

Born on March 18, 1912 at Borwadi, Bombay, Shri Oke obtained his B.Sc. degree in 1934 from Bombay University. In 1939, he took his B.E. degree from the same University. In 1940, he joined as Engineer in Hindustan Construction Co. During 1941-42, he was Structural and R.C.C. calculator in M.E.S. During the years 1942-47, he was Sub-divisional officer, M.E.S., and was responsible for the construction of army camps and water supply works, etc. From 1947-49, he worked as Assistant Engineer, P.W.D. M.P., and was responsible for the construction of buildings, roads, culverts, and major bridges like Rihand bridge. During 1950-56, he served as Executive Engineer, Durg; and completed the construction of roads, strong rooms for banks, school buildings, bridges, and irrigation works, etc. In 1956, he was promoted as Superintending Engineer (Irrigation). He worked on various projects like Gangulpara in Balaghat, Sagarnali project in Seoni, Dhuwadhar project in Shajapur, and Mola Dam project, etc. in the same capacity until 1962. He was then promoted as Deputy Chief Engineer, Irrigation Branch, M.P.

Shri Oke joined the Institution as Associate Member in 1948 and was transferred to Member in 1963.

Shri S. K. Panikkar

Shri S. K. Panikkar, M.A., B.Sc. (Eng.), M.I.E., died on March 16, 1966.

Born in 1895 at Ambalapuzha, Kerala State, Shri S. K. Panikkar passed Intermediate from Madras University in 1913. He passed B.Sc. (Eng.) degree with first class honours from the Edinburgh University in 1916. During the same year, he also took M.A. degree in Political Economy and Moral Philosophy from the same University.

He had his practical training in London up to 1919, specializing in Reinforced Concrete. He joined Bengal Nagpur Railways and worked there in different capacities. During 1921-26, he was Assistant Engineer; from 1927-32, he worked as Acting District Engineer. Again, during 1933-36, he served as Assistant Engineer and was later promoted as District Engineer. During 1943-47 he worked as Deputy Chief Engineer and then as Chief Engineer from 1947 to the date of his retirement in 1949. He was responsible in Bermokaranpura Construction for the works of very heavy rock cutting and two major bridges on Kunar river. He was also responsible for works like repairs of heavy breaches on railways, well sinking, girder erection, and coffer dams, etc.

Shri S. K. Panikkar joined the Institution as Associate Member in 1925, and was transferred to Member in 1948. He was Chairman of Kerala Centre during 1949-50 and the Member of the Executive Committee for a number of years. After his retirement, he was closely associated with the activities of Kerala Centre.

Shri T. Rama Rao

Shri Tirumakudlu Rama Rao, B.E., M.I.E., died on May 7, 1965

Born in 1891, Shri T. Rama Rao passed Intermediate examination from Bombay University in 1911. In 1914, he took his B.E. degree from the same University. He started his professional career as a Sectional officer and was responsible for cut-stone dressing, etc. in Krishna Raja Sagar Dam. During 1915-18, he was Sub-Divisional Officer at Chamaraj Right Bank Canal and was concerned with gauging operations, etc. During 1918-26, he worked at Anicut canal and Guindy Rating station. During 1927-32, he was responsible for works such as tunnel excavation, sinking of shafts, etc. at Cauvery Branch excavation. From 1932-40, as an Assistant Engineer, he was responsible for works such as maintenance of buildings, roads and canals, gauging operations, tunnelling, R.C.C. ducts, etc. In 1940, he was promoted as Executive Engineer and was in charge of construction of many canals and distributaries, reservoirs, dams and channel works, girder bridge, concreting of roads, improvement of hillroads, survey and estimating of earth dams, etc. In 1946, he was promoted as Superintending Engineer, and soon after retired. He was one of the first organizers of National Institute of Engineering, Mysore and was its honorary professor and principal. Later he served the Institute as honorary treasurer as well.

Shri T. Rama Rao joined the Institution as Associate Member in 1933 and was transferred to Member in 1948.

CORRIGENDUM

'TO VOL. 15, NO. 8, APRIL 1966

Page 73, under Obituary, instead of 'Punam Chandra Agrawal', please read 'Pitam Chand Agrawal'.

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, industrial and other organizations employing engineers. It is hoped that employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

SITUATIONS VACANT

PRATAP BATTERY CORPORATION, Jinnah Tower, Guntur, Andhra Pradesh. WANTED one qualified Battery Expert with five years experience in a Battery Factory in the product line. Apply with testimonials, pay required.

WELL KNOWN INDIAN CONSULTING ENGINEERS shortly opening branch in West Germany require fifteen structural design engineers and draftsmen. Those having worked in Germany or knowing German language to apply with full particulars of qualifications, experience and salary expected (Office ref. E.S. 229).

SITUATIONS WANTED

YOUNG ENGINEER, age 32, passed Sections A and B (Mechanical Engineering) of A.M.I.E. (India), passed B.Sc. of Calcutta University in Pure Science, and Diploma in both Mechanical and Electrical Engineering of Jadavpur University; having 10 years experiences (including recognized engineering apprenticeship training) in the maintenance and erection of mechanical and electrical machines and plants and in planning, scheduling and progressing with knowledge in Machine Design. (Office ref. E S. 225).

CHEMICAL ENGINEER, 30 years, B.Sc. of the Mysore University, passed Sections A and B examinations of the Institution of Engineers (India), having two years of apprenticeship, and three years of supervisory experience in a big chemical factory manufacturing explosives, knowing Kannada and Tamil languages, seeks suitable change, preferably to development/professional service side. Also willing to be sponsored for higher studies on service contract. Present emoluments Rs. 345. (Office ref. E.S. 228)

R. C. De, M.I.E. (Ind), A.M.ASCE (U.S.A.), age 59 years, robust health, 20 years experience in big hydro-electric and flood control projects of India and Burma; executed construction work most economically by heavy earthmoving machineries, specialised in pneumatic and diamond drilling; open for immediate engagement in big projects as Construction Field Mechanical Engineer or Consulting Engineer. High credentials for efficiency and integrity.

Write :—Pal Chowdhury Street, P.O. Ranaghat, District Nadia, West Bengal.

STUDENT of the Institution of Engineers (India), age 23, passed diploma in civil engineering in first division from the University of Roorkee, having about 3 years experience in survey and investigation for hydro-electric projects, collection of rainfall data, preparing estimates and execution of R.C.C. foundations for factory buildings, precasting and R.C. columns and beams, salary expected Rs. 400.00. (Office ref. E.S. 230).

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TEXT BOOK ON HIGHWAY ENGINEERING & AIRPORTS
by S. B. Sehgal & K. L. Bhanot

2nd edn., p. 544, 20 chs. on Highway & 11 chs. on Airports ; 200 fig., History of Highways & Airports—planning, financing & administration ; Modern geometric Designs suitable for the developing countries in Asia & Africa thoroughly illustrated and discussed. List of National Highways & Air Routes and Geometric Standards for Highways at a glance appended .. 15/-

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DESIGN OF MODERN STEEL STRUCTURE by L. E. Grinter

1st Ind. Reprint 1965, p. 419, 17 chs., 265 fig, 31 tables, 53 Design Sheets, 281 problems with illustrations. Plastic Design based upon Collapse Loading and Design of a Tall Building, the latest in Modern Steel Structures, are adequately dealt 14/-

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Scheme of Institution Publications

Publication	Symbol	Frequency per year	Month of publication											
			January	February	March	April	May	June	July	August	*September	October	November	December
Bulletin	*BU*	12	BU5	BU6	BU7	BU8	BU9	BU10	BU11	BU12	BU1	BU2	BU3	BU4
Civil Engineering Division Part	*CI*	6	CI3		CI4		CI5		CI6		CI1		CI2	
Mechanical Engineering Division Part	*ME*	6	ME3		ME4		ME5		ME6		ME1		ME2	
Electrical Engineering Division Part	*EL*	6		EL2		EL4		EL5		EL6		EL1		EL2
Electronics & Tele-communication Engineering Division Part	*ET*	3	ET2				ET3				ET1			
Chemical Engineering Division Part	*CH*	3		CH2				CH3				CH2		
Mining and Metallurgy Division Part	*MM*	3			MM2				MM3				MM1	
Public Health Engineering Division Part	*PH*	3		PH2				PH3				PH1		
General Engineering	*GE*	3	GE2				GE3				GE1			
Hindi Section	*HI*	3				HI2				HI3				HI1

* A new volume commences in September each year and ends in August next year.

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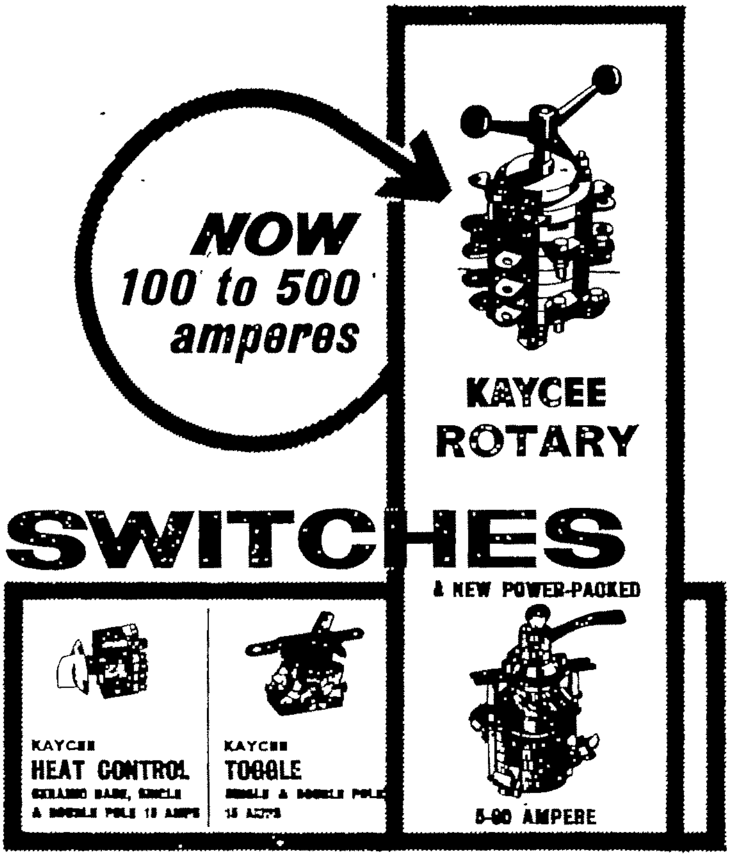

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THE BULLETIN

OF

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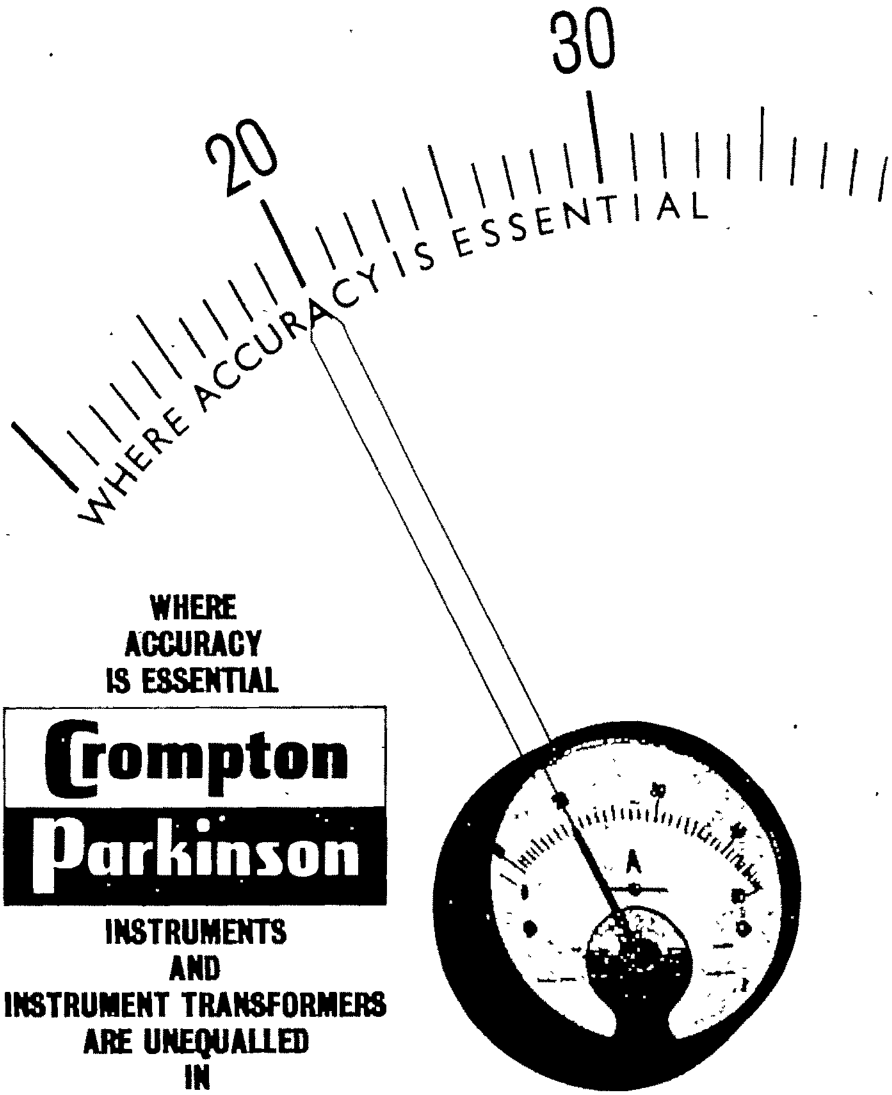

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METRIC CHANGE-OVER IN ENGINEERING INDUSTRIES

V. B. Mainkar

Non-member

Director (Weights and Measures), Ministry of Commerce,
Government of India, New Delhi

Introduction

A reform of weights and measures at first sight appears to be a prosaic and simple affair, not worthy of much attention. Such an over-simplified view of a major technical reform does injustice both to the people and the economy.

The urgency of the change-over was keenly felt by the Government of India when the Second Five Year Plan, with its emphasis on industrialization, was in the offing. This was put effectively into words by the late Prime Minister, Jawaharlal Nehru, who said, 'Above all, in the development of science, industry, and new techniques, the use of the metric system is essential. Indeed it has to be used anyhow. To have two systems in the country, one for our growing industry and science and one for the other purposes of daily life, will not only be confusing and wasteful but a burden to all concerned.'

Legal and logical tasks

The reform of weights and measures could be broadly divided into two groups of activities: (i) the tasks imposed by law, and (ii) tasks imposed by the logic of the reform.

Under the Weights and Measures Laws passed by the Centre and the States, it is now illegal to use units of weights and measures other than metric in transactions for trade or commerce. It also makes illegal any references to non-metric units in quotations, orders, contracts, documents or other laws. The provisions of these laws are being implemented through suitable Government agencies, *viz.* the Weights and Measures Organizations at the Centre and in the States. The position today is that the use of metric weights and measures is common all over the country. An integration of the country in this field, which had eluded us for centuries, is being achieved progressively in independent India.

The second aspect regarding the logic of the reform brings the technologist and the engineer effectively into the picture. Before considering the various problems, a short survey of what has been done so far in this field may not be out of place.

In the field of industry, the change-over was introduced in the early years of the reform for purchases and sales. The productive equipment or the dimensions and other design specifications of the products and machinery were not touched. Every industry thus asked for and supplied quotations in metric units and kept accounts of purchases and sales in metric units. It was also declared that all new machinery obtained or new plants set up should be fully designed in metric system or should at least be capable of production into metric dimensions or quantities, even if it was not designed on the metric system.

The Standards

Simultaneously, the Indian Standards Institution (I.S.I.) was requested to undertake a far-reaching programme of prescribing specifications, codes of practice, handbooks, etc. in terms of the metric system. The I.S.I., whose report on the adoption of the metric system sumbitted to the Government of India in 1949 had led to the metric reform, lost no time in settling down to the task.

Standards for steel sections were quickly laid down in rational metric dimensions. Production of steel sections to these standards was undertaken in the three new steel plants which were set up during the Second and Third Plans. The Tata Iron and Steel Co. and Indian Iron & Steel Co. changed their rolls and other equipment and changed over to the production of the new sections. The change-over in such a basic industry as steel in the early years gave a good start to the reform in steel using industries.

Another early decision of the I.S.I. was the adoption of metric screw thread profile for India in accordance with the International Organization for Stnadardization. A field in which I.S.I. established spectacular results was the standardization of weights, measures and weighing and measuring instruments which made possible due to the early legal introduction of metric weights and measures in the country.

As the work of the I.S.I. gained momentum, opportunity was taken to introduce these standards in some industries. This work was, however, comparatively arduous in many spheres for reasons which will be considered later

Reform in education

Side by side with these developments, a change-over was being effected in school and college education—technical and engineering. Textbooks for schools were revised so that all references to weights and measures were to the metric units alone. In technical and engineering education a 3-year phased programme was adopted so as to impart teaching of all technical subjects and in all classes by 1964-65. In many technical and engineering colleges, the change was effected according to the schedule, while in others it would be achieved in the next year or so.

One of the chief difficulties was the non-availability of textbooks using the metric system. The books prescribed earlier were mostly written by British or American author and used British units. To replace these, the textbooks written in English using metric units, were not available. Translation of French, German or Russian books was not undertaken by our technical teachers due to several reasons. This non-availability of metric technical textbooks exposed our utter and pitiful dependence on British and American books. Fortunately, the younger generation of teachers took up the challenge and new or revised Indian technical textbooks making full use of the metric system are now being published in ever increasing numbers Our dependence on foreign textbooks is thus being overcome rapidly

In polytechnics also, the teaching of metric units exclusively has been taken up in earnest manner. The Industrial Training Institutes are still lagging but it is expected that here also the change-over would be completed soon.

More and more engineers have been getting training in the 'metric' countries and they have also been fruitfully using their knowledge.

The educational field has been reviewed in detail because that is the source for engineers and technologists of the future whose knowledge will be utilized in the rapid and rational industrialization of the country. With the new industries working fully in the metric units, these engineers will not have to face the difficulties due to change-over.

Psychological preparation

There is, however, a large proportion of the industry which still works on F.P.S. machinery and dimensions. These industries create a bottleneck for themselves and others if they do not take quick steps to adopt the metric system in its proper spirit. Instances are not rare when a demand is made for a 50.8 mm. (2 in.) product but the metric product of 50 mm. is lost sight of. A storage tank may be designed for, say, 10,000 gallons and then assigned a capacity of 45,459.6 or 45,460 litres. The designer never thought originally of a capacity of 40,000 or 45,000 or 50,000 litres, i.e. 40, 45 or 50 kilolitres. This sort of 'translational' thinking merely creates difficulties for everyone.

Perhaps the engineer who commits these 'atrocities' justifies his action by pointing out that his training was in the F.P.S. system and, therefore, he could only visualize F.P.S. quantities and not metric ones. Such an attitude indicates mental lethargy or intellectual inertia which is incongruous in a developing country. The very process of developing the country requires that we should evolve new ideas, new thoughts, new techniques and new procedures. Intellectual intertia towards the new avenues of progress would only hamper our development in proportion to the power such persons command. Instances are also not rare where heads of firms and organizations, who had to lead a team of a hundred or thousand engineers, expressed the view that as they would retire in 2 or 3 years, they did not wish to worry about the metric change-over They want to pass on the task to their successors. Imagine the frustration of the subordinates who want to go ahead.

The first essential requirement of the change-over to the metric system in industry is, therefore, the shedding of inertia and the assiduous cultivation of the ability to get a mental grasp or 'feel' of metric units. In other words, in spite of initial difficulties, the engineer trained in F.P.S. units must, whatever his age or status, think of metric units and get rid of the habit of mental conversion which often leads to 'strange' results. No time should be lost in this process.

After considering the paramount need for psychological preparation, we may now consider what the change-over implies in terms of physical work

Availability of standards

A primary requirement of the change-over in industries is the availability of good, metric standards. The change-over is not a mere process of multiplaying inches by 25.4 mm. or lb. by 453.59 gm. or gallons by 4.54596 litres. It is a complete revision of old standards and establishment of those which have a thoroughly metric rationale or logic and can be used by engineers without getting into unnecessary calculations. The I.S.I. has done a magnificent task by providing the bulk of these standards within the short period of 8-9 years. Keeping the industrial progress in view, the I.S.I. has also further rationalized many standards which had been prepared in the early stages of the metric reform. The vital base for the industrial change-over has thus been firmly laid by the I.S.I.

Production of materials

The next stage is the production of materials according to Indian Standards. The new industries found little difficulty in adopting the metric standards. But old and established units whose production was based on the British system sometimes experienced more difficulties. Many such industrial units pointed out that as there was no consumer demand for the metric products, they continued to produce only in.-based products. The consumers, on the other hand, stressed that as the metric products were not available, they could not effect the change-over. This deadlock had to be broken. It was, therefore, appropriate that government departments and others concerned should have started the change-over so that a substantial demand was created for metric products. Experience showed that others then fell in line in the course of time. The work done by the Railways, P. & T., Defence, etc. in the engineering field is noteworthy.

The change-over could be introduced in simple steps even by the older industries. For instance it could be effected in such simple arithmetical quantities as the nominal dimensions of a fan, like 1,400 mm. instead of 56 in. (1,422 mm.) or 300 mm. in place of 12 in. (305 mm.) and so on. There is no need to indicate nominal dimensions as 1,422 mm. or 305 mm. The consumers are now fully aware how much is a metre, a kilogram or a litre. They will not experience great difficulty in getting accustomed to the new units if the industry and trade adopt them.

Sometimes, however, a change is effected merely to satisfy legal requirements. Such superficial changes only create difficulties for the ultimate user. For example, it was recently noticed that the capacity of pressure cookers was being given in litres but the cooking literature indicated quantities of water required and commodities cooked in pints, ounces and pounds. Imagine the housewife who knows what a litre of milk or one kilo of rice is, struggling with pints and ounces which she has never used in her life. Such a lop-sided change can be minimized if the producers carefully scan all the literature and specifications of their products supplied to consumers. This applies not only to cookers but also to the majority of engineering products

Change-over in products

The next requirement of an effective change-over is that production should be switched to metric units, particularly in cases where the change is more in the rational denomination or dimension of the product than in its design. It may require the replacement of dies or slight adjustment of machinery or tooling. It can be effected when dies or tools are replaced in the regular production schedule. It could be easily effected over a short period. Instances are production of nails, wood screws, rivets, ordinary fasteners of various types, wires and wire based products, tiles, doors, windows, building materials, etc. These are the cases in which the ultimate consumer or user would not have to change his design or equipment substantially to accommodate the new products.

The next step is more difficult and demands an ability to design products in the metric system. It is in this sphere that a number of artificial and genuine difficulties are felt or created. We may consider the principal ones.

We may take on old and established industry which has been producing in.-dimensioned machines. The machines are assembled from a number of parts and components. In this case the change-over may entail that each and every part would have to be redesigned. The producer would not be able to escape the need to redesign the machine, because the production of the raw materials, etc. which he would require for the old assembly would be gradually shifting to rational metric specifications. A progressive manufacturer would avoid the process of obsolescence of his design, if he takes timely steps to redesign his machine so that he could procure the necessary tooling, etc. in proper time. The older industries working on the F.P.S. system must realize this limitation to their future activities in the present context. They will have no right to complain later.

The new design ought to be based on the Indian Standards Specifications for the various products and materials. It would create needless difficulties if I.S.I. standards, where available, are replaced by standards of other countries like Germany, France, Russia, Italy and Japan, simply because they are on the metric system. There may be differences of a vital character. For example, recently difficulties were expressed in the use of I.S.I. screw threads by some firms because the specifications of their principals, though metric, had a different profile. It is obvious that such an attitude to the change-over will create small pockets of demand for special products which are outside the normal production line and thus add to the cost of the final product.

Self-reliance

Such an attitude is also contrary to the need for self-reliance. India is the only country where machines designed by innumerable countries and produced to a variety of specifications are being used. A visit to any factory producing small tools would show that tools to I.S.I., I.S.O. British, German, French, Russian or Japanese standards are produced to satisfy the requirements of users. The capacity for small tools, limited as it is, has to switch production every so often, leading to waste in production.

What is much worse, if we do not need the Indian Standards and raw materials, we create a dependence for spares on other countries at the cost of the detriment of our own industry. If supplies of spares and components are held up for any reason, as was witnessed recently, the Indian industry would find itself on the verge of a collapse.

Collaboration

For a country which wishes to develop quickly, it is necessary to acquire the know-how initially from other advanced countries. India has sought and obtained collaboration from every advanced country in the world but mostly on technical terms dictated by the collaborating country. The result is that designs based on specifications used in the collaborating country are produced in India. The collaborating firm may be British or American in which case the equipment, spare parts and components are in the in. system, and if the collaborator is from France, Germany, Japan, Russia, etc., they are in the metric system. To the extent that the design is metric based the problems of change-over are simpler. But when it is in.-based, the problems become complicated. If we go on producing to the design of the collaborating country, whether in.-using or metric, year after year without taking steps to digest the know-how and evolve our own design based on Indian produced raw materials conforming to Indian Standards, we are merely perpetuating a system of helpless dependence on other countries. We are also encouraging the expenditure of valuable foreign exchange on royalties and imports of components and spare parts which could be produced in the country. An instance may be cited. A factory producing pumps was said to have developed 70% indigenous content and was confident of going upto 85% in a year or two. The hitch in 100% switchover was that the delivery assembly, the very heart of the pump, was imported and no steps had been taken to design it in India after many years of collaboration. The delivery assembly which constituted nearly 60% of the value of the pump, was treated as just one component and classed with other parts like nuts and bolts as one item, leading to the final figure of 70% indigenous content

If we continue this habit of dependence on collaborators for planning and designing, and do not work hard to improve our ability to re-design and produce parts, accessories, etc., we are creating a pitfall for our own industry. It is, therefore, essential that industries which have already established collaboration with other countries should take immediate steps to develop designs based on Indian products.

Development of Indian designs

The sequel to this line of thinking is that in any new collaboration it should be ensured that the designs are based on Indian raw materials from the very beginning. Where this is absolutely impossible, it should be provided in the collaboration agreement that the designs would be based on and produced with Indian materials conforming to Indian Standards well before the period of collaboration ends. It is also necessary that the periods of collaboration should be shortened so as to achieve early self-reliance and independence of production.

An important event in the field of collaboration, particularly with the U.K. firms, is the decision of the British Government to adopt the metric system in industries within 10 years, *i.e.*, by 1975. This decision would be immediately seen to be of advantage to India in view of our progress in the adoption of the metric system. Future collaboration with the U.K. firms should be on metric terms. Old collaborations could be renewed in terms of metric units. There is, thus, no further need to create pockets of special specifications where the U.K. firms are concerned.

Once a certain type of industry is set up with collaboration, it should be carefully considered whether a second plant or expansion of the existing plant should not be done fully with Indian know-how and raw materials.

The aspect of collaboration has the metric undertone because all the basic standards, raw materials, etc. have to be produced only in metric units in implementation of the programme of the change-over. It cannot be truthfully said that India has fully adopted the metric system until all machinery and products are in metric units.

Necessity of a quick change-over

For the process of self-reliance to be meaningful, this fundamental change-over in designs and machinery should be effected quickly. A long-drawn programme would defeat the very purpose of self-reliance, *viz.* to free the industry substantially from technical and other dependence on other nations or experts. This process, however, does not mean the scrapping of the existing machinery or products. Existing machines have to be continued in use for their life, with adaptation or re-calibration, where necessary. Spare parts for these machines would have to be provided for some years to come. But this should not be taken as an argument for indefinite continuance of old machinery. Similarly, spare parts for a long-life product like a locomotive will also have to be provided. But from a given date, which should be not more than say a year or two off, all such products should be designed and produced on the basis of rational metric standards.

Conclusions

We have had a long look at the basic need of a change-over to the use of metric units in Indian industry. In short, we may state the argument as below:

(i) The metric change-over has to be effected in Indian industry without loss of time.

(ii) As a pre-requisite to this process, all engineers trained in the F.P.S. system, must cultivate the habit of thinking in metric units. This can be achieved by making conscious efforts to use metric units without reference to F.P.S. units. A conversion table should be referred to or required only very rarely.

(iii) The standard specifications, codes of practice, handbooks, methods of test, etc., necessary for the metric change-over have already been laid down by the Indian Standards Institution.

(iv) In many industries production has been already geared to the new metric specifications.

(v) All new industries are producing materials according to the rational metric specifications.

(vi) Industries which have not effected the change-over should do it quickly.

(vii) Industries in which only the nominal dimensions require change should switchover as a group immediately.

(viii) Industries which require change of dies and some tooling, should select a date in the near future and take effective steps to change production to conform to the appropriate Indian Standards by that date.

(ix) Industries which require change of design, either entirely or partially, should lose no time in re-designing the product. Care should be taken to ensure that such re-designing is based only on materials conforming to Indian Standards.

(x) Where collaboration with a foreign country or firm is concerned, it should be the policy to set up only the first unit with foreign help. Subsequent units or expansion of existing ones should be carried out with local know-how and expertize.

(xi) When entering into new collaborations, it should be ensured that the design is based on products or materials conforming to Indian Standards.

(xii) Where such a step is absolutely impossible, a stipulation should be made in the collaboration agreement that the design of the concerned product would be converted to Indian Standards and materials well before the expiry of the collaboration period.

(xiii) If the above steps are taken without loss of time, the aim of self-reliance would be achieved and industry freed substantially from over-reliance on other countries for know-how, expertize, raw materials, spare parts and components

(xiv) All these results flow from the conscious effort to adopt the metric system rationally in our industries, because all the new Indian Standards which have to serve as the foundation for the change-over are based fully on the rational use of the metric system.

Recommended readings on metric change-over

1. 'I.S: 786—1956, I.S.I. Handbook of Quantities, Conversion Factors, Formulae, and Tables'.

2. 'I.S: 787—1956, Guide for Interconversion of Values from one System of Units to another'.

3. 'I.S: 786—1956, Conversion Factors and Conversion Tables'.

4. 'Training in Metric System for Engineering Industry', 2nd edition, Ministry of Commerce, Government of India, New Delhi 1965.

5. 'I.S: 1105—1957, Method for Precise Conversion of Inch and Metric Dimensions to Ensure Inter-changeability'.

6. 'I.S: 1722—1960, Guide for Specifying Metric Values'.

TRIEF CONCRETE FOR CONSTRUCTION OF DAMS

T. B. Modak

Non-member

The details of the Fourth Five Year Plan are yet to be known and therefore the extent of building and construction activity connected with this Plan remains to be assessed. We may safely assume that the cement production is going to further fall short of the demand even if vigorous efforts are made towards increasing the production of cement by the installation of new plants or expansion of existing units, by firms already in this industry or by the cement corporation which is proposed to be set up shortly.

There is one field of construction where Portland cement can be saved to an extent of 60-70% by using 'Trief' concrete in the construction of concrete dams for hydro-electric schemes or irrigation and large water supply projects which consume considerable quantity of cement in the mass concrete dams associated with such schemes, if conventional concrete is used towards their construction. If, on the other hand, 'Trief' concrete which has been successfully used in the construction of dams in Europe and the U.K. is utilized, nearly 60-70% of Portland cement can be saved which could be made available for other constructional activities where such concrete cannot be used, specially in the light of present acute shortage of cement in the country.

What will be described later is done with the sole purpose of initiating the concept of using 'Trief' concrete amongst engineers who will be directly or indirectly concerned in the planning and execution of heavy dams for the hydro-electric, irrigation or major water supply projects under the next Five Year Plan.

The reader may get the impression that economy and saving of cement is achieved at the cost of the quality and strength of mass concrete in dams which, as every engineer knows, cannot be done in the construction of such important structures. Actually, what is being achieved in the use of 'Trief' concrete is that the cement content is, in no way, reduced but portion of the cement is substituted by granulated slag which has the equivalent or complementary properties of Portland cement, capable of homogeneously mixing with the same when the granulated slag is inter-ground with Portland cement clinker.

It is common knowledge that the blast furnace slag cement is nothing but granulated slag from steel plants inter-ground with clinker in the proportion of 35 : 65 or 30 : 70 respectively and that the slag at Jamshedpur as well as at Bhilai is now being successfully granulated in our country from which slag cement is being produced to an extra advantage. It is well known that the slag cement has exactly the same properties as the portland cement and, in fact, in some respects it is superior to the ordinary one. In fact, due to fine grinding of slag (between 4,000-3,500 sq. cm. per gm.), 'Trief' concrete attains higher strength with time than concrete with ordinary cement.

In case of 'Trief' concrete, what is being done is that the granulated slag is wet ground in 'ball mills' and kept in the form of slurry, having about 30% moisture and stored in tanks where it could be kept agitated until pumped and delivered into the mixing drum of the concrete batch mixer when at the same stage portland cement is fed in the batching plant. The slurry as delivered into the concrete mixer known as 'Trief' slurry, which is mixed with Portland cement in the desired proportion—say, 70 : 30 or 60 : 40 mixture being known as 'Trief' cement is being used for the concrete in the required proportion.

As regards specific advantages in using 'Trief' concrete in construction of dams apart from saving of Portland cement are that the temperature rise in such concrete is only 60% of that when Portland cement is used; besides this, there is almost complete absence of shrinkage cracks. Thus, the low heat properties of 'Trief' cement which are of considerable importance in the construction of dams helps towards substantial saving in the construction period by speeding up the construction cycle. It is claimed that the period of construction can be reduced to 50% at least. 'Trief' concrete has, for all practical purposes, the same strength as that of concrete produced out of Portland cement, but it should be noted that the ultimate strength falls off rapidly when slag proportions exceed 75%.

In conclusion, it may be stated that 'Trief' concrete is ideally suited due to low heat of hydration for the construction of mass concrete dams. This concrete has, of course, to be made under fullfledged laboratory control to ensure that the concrete fully meets the specifications laid down by the designer as regards its strength, etc. For 'Trief' concrete, all that needs to be done, therefore, is to install a 'ball mill' for wet grinding of granulated slag transported to sites from steel works.

The total Portland cement that can be thus saved in the construction of hydro-electric schemes, major irrigation and water supply projects in the next Five Year Plan can be assessed on the number of such schemes contemplated. To give a rough idea, it may be interesting to note that if 'Trief' concrete had been used in the construction of Vaitarna Dam for Bombay's water supply and Koyna Dam for the hydro-electric project, the saving of ordinary cement would have been at least 74,000 tons and 138,000 tons respectively.

Monograph on USE OF FLY ASH IN BUILDING INDUSTRY

The cost of the above Monograph, published by the Institution, has been reduced to Rs. 2.50 in accordance with the decision of the Council. Copies are available for sale with the Assistant Secretary (Technical) at the Headquarters Office.

Contemporary World Engineering Project Series—30

Members are invited to contribute to this Series the special articles featuring major engineering projects with which they have been associated in any manner. Articles should be preferably accompanied by photographs and illustrative sketches.

PLOVER COVE WATER SCHEME*

Introduction

The Plover Cove Water Scheme is a large-scale and long-term project for doubling Hong Kong's water supply and for providing sufficient storage capacity to maintain the supply through extended dry periods. Ranked as one of the best natural harbours in the world, Hong Kong on the south eastern coast of China occupies 391 sq. miles of islands and mainland. When completed in 1968, the new scheme will treble the colony's water storage and provide sufficient storage capacity to maintain the supply through extended dry periods. The latest census in 1961 showed that 82% of the population of 3,120,000 persons lived in 13 sq. miles of the urban area which is 3½% of the total land area of the colony. The rest of the land area forms mostly steep hillsides of the New Territories, leased to the British Government for 99 years in 1898.

From the time of its foundation as a trading port, more than 100 years ago, until the present day when it is a densely populated and industrial area, Hong Kong has suffered from constant water shortages. The rainfall, averaging about 85 in. per year, is concentrated in the summer months between May and September. The problem has been to provide enough reservoir storage to ensure an adequate water supply through the dry winter months. Since the end of the last war, the Public Works Department has engaged in an extensive programme of reservoir construction. The demand has, however, consistently outstripped the supply. In 1960, the Government signed an agreement with the Chinese Government, under the terms of which China has supplied Hong Kong with 5,000 million gallons of water annually. In 1964, a new agreement was signed, guaranteeing the sale of an annual 15,000 million gallons. In order to cope with the expected increase in the demand for water over the next ten years, the Plover Cove Water Scheme was conceived. An inlet of the sea in Tolo Harbour on the northern mainland side will be sealed off, emptied of seawater and refilled with fresh water. Roughly 3½ miles long and 1½ miles wide, the Plover Cove Reservoir will have a useful storage capacity of 35,000 million gallons of fresh water when the main and subsidiary dams have been completed.

The overall project skirts the northern and western sides of Tolo Harbour, forming an 'L' on its face. Raw water for the system is channelled through the tunnels principally to Plover Cove Reservoir from Tai Po river and numerous streams on the west and from the colony's northern rivers.

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* *Courtesy* Allis-chalmers, Milwaukee, Wisconsin, U.S.A

Maintaining service roads in the main tunnel

Stage 1

Stage 1 provides for the conveyance of raw water diverted from the Tai Po River and collected from the mountain streams between Tai Po Tau and the Shing Mun River through about 8 miles of tunnels *via* Lower Shing Mun balancing reservoir to a treatment works at Sha Tin. Abstractions from the Tai Po River will include water diverted from Tau Pass which, in turn, will be augmented with supplies pumped from the Colony's northern streams. In addition, Stage 1 construction includes an inflatable, neoprene-coated nylon dam and a pumping station (both at Tai Po Tau) and a second pumping station at the treatment works. The treated water will be pumped to Kowloon through pipelines to be laid in the Lion Rock tunnel.

Construction of Stage 1 (the western part of the system) is nearly completed. This includes:

(i) Ten miles of main and spur tunnels from near Tai Po Tau to the Lower Shing Mun balancing reservoir and then to the Sha Tin treatment works and pumping station;

(ii) The Lion Rock road and pipeline tunnel from the treatment works to the service reservoirs from Kowloon; and

(iii) The four pumping stations, treatment works and distribution pipelines.

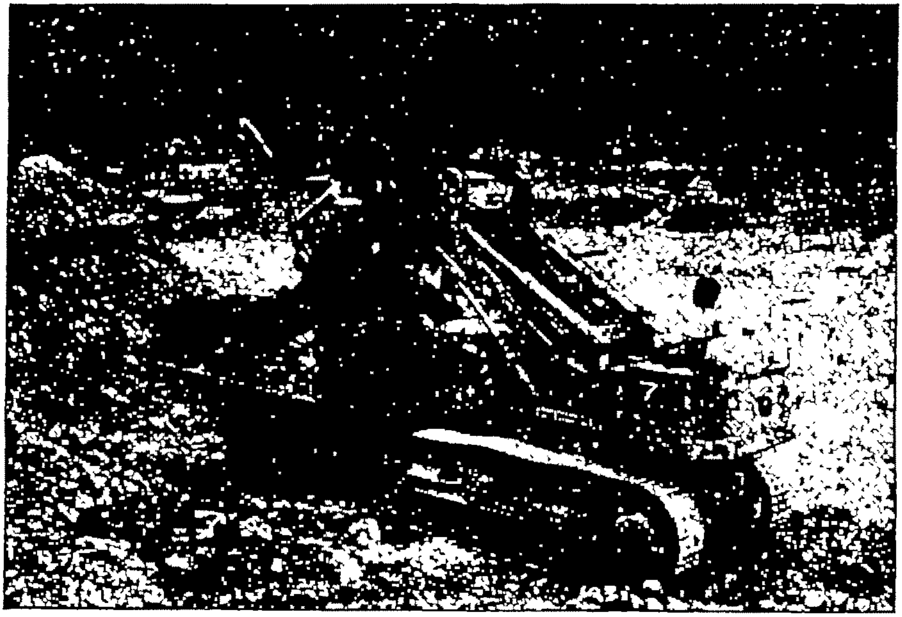
Two subsidiary dams will be needed: one to close the gap between Harbour and Tung Tau Chau Islands; and the other between Tung Tau Chau and the peninsula forming the south eastern boundary of Plover Cove. The crest of Tung Tau Chau Island itself will be sliced off and surfaced with concrete, forming the overflow spillway from the reservoir to the sea. The contract to build the main dam and subsidiary dams, one of the three left for the second stage of the Plover Cove Water Scheme, also includes pumping out the seawater from the newly formed reservoir. A temporary pump-

A 240-h.p. Behemoth working on the Plover Cove water supply project

ing station will house the permanent pumps during this final operation of the five-year contract. Then, the pumps will be transferred to the permanent structure.

Stage 2

Stage 2 involves the conversion of the large coastal inlet of Plover Cove in Tolo Harbour into an impounding reservoir by the construction of a main dam, two subsidiary dams and a spillway, together with the driving of a main tunnel from Tai Po Tau to Plover Cove. Tunnels branching off this main tunnel and separate system of secondary tunnels will tap indirect catchments to supplement the natural runoff into Plover Cove Reservoir. The main tunnel will have the further functions of conveying impounded water from Plover Cove into the Stage 1 system and, at appropriate times, of transmitting Stage 1 surpluses into storage in Plover Cove Reservoir. Although, gravity flow directly from the reservoir will sometimes be possible, a low-head pumping station will be required at Tai Mei Tuk to draw stored water from Plover Cove Reservoir and to raise the level high enough behind a weir at the adjacent portal to enable the water to flow back through the main tunnel to Tai Po Tau.

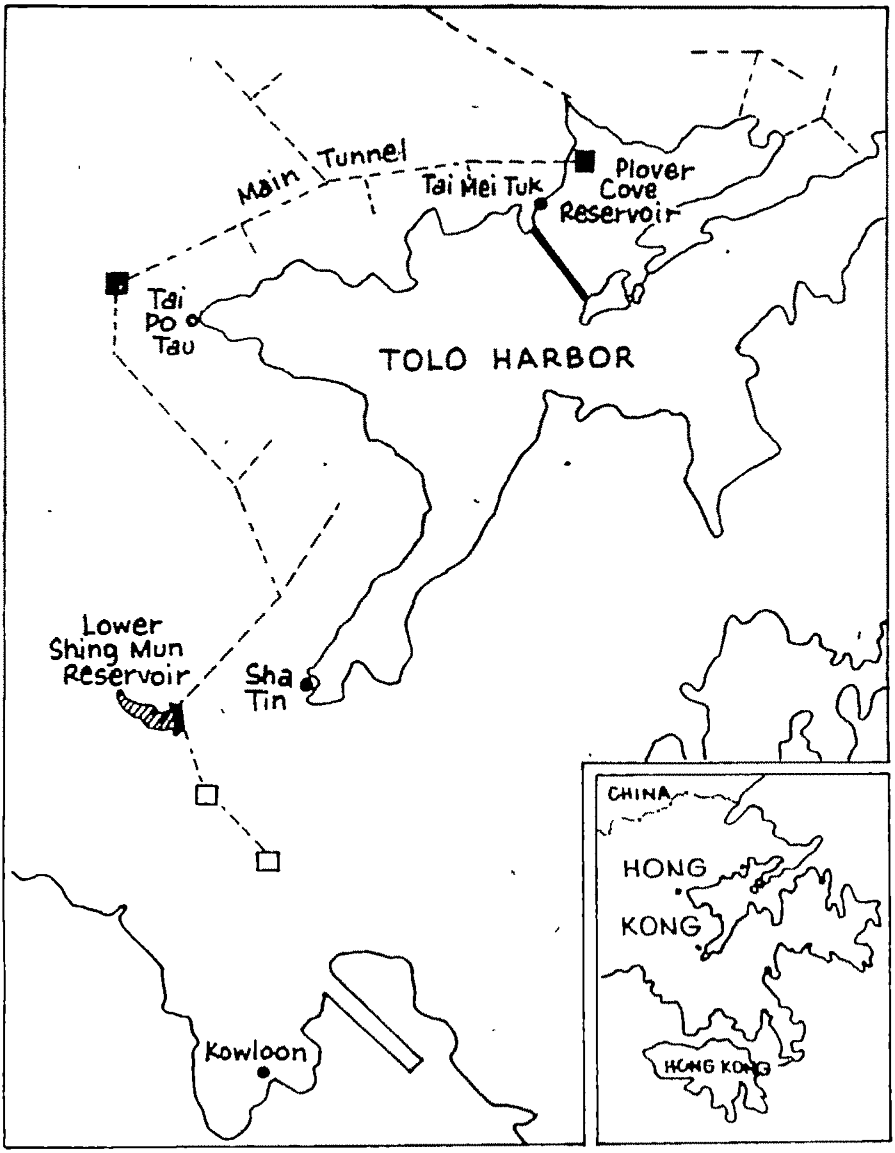


Construction of pathway to the tunnels in progress

The Stage 2 tunnel system is expected to be completed in April, 1967. Four spur tunnels off the main tunnel, with a combined length of about three miles will connect with stream intakes. Two miles of catch-waters will also be constructed. In addition, a 2½-mile long tunnel with a diameter of 12 ft. will channel water from a stream intake on the north Nam Chung side of the Cove directly into the reservoir.

Description of main contracts

(i) *Plover Cove main and subsidiary dams and Tai Mei Tuk Pumping Station*



Map showing the scheme

The main dam, which will extend from the end of the Tai Mei Tuk peninsula to the north-west shore of Harbour Island, will have a crest length of about 6,800 ft. and a maximum height of construction of about 130 ft. The dam will be built by first dredging out some 40 ft. thickness of the sea bed in an almost equal depth of water to remove the very soft clay which is too weak to form the foundation for the dam. This will expose stronger clays and generally clayey sands upon which decomposed rock (*i.e.* residual soil), sand and rock will be bottom-dumped and placed to the full height of the dam. A wave wall and road along the crest of the dam will complete the structure. The main bulk of the dam will consist of decomposed rock which will be protected from wave action by graded rock fill. Sand will be incorporated in horizontal layers and vertical piles located at intervals through the decomposed rock to provide drainage and so to minimize pore pressures in the fill, especially in the saturated material deposited below the sea-level.

The dredged clay will be deposited in a spoil area located a mile and a half to the west of the dam line while the constructional materials will be obtained from borrow areas adjoining Tolo Harbour. It is envisaged that decomposed granite will come from the hillsides of White Head and Ma Liu Shui, fresh granite from quarries to be opened in Turret Hill and sand from various areas on Tolo Harbour itself, all being transported by barge to the site of the dam. In the later stages of construction, decomposed granodiorite will probably be excavated from the Shuen Wan peninsula and transported by road to be placed in the dam above sea level. The borrow and quarry areas will be terraced and essential road and drainage works will be carried out to provide sides for future development.

The two subsidiary dams will close the gaps between Harbour Island and Tung Tau Chau and between Tung Tau Chau and the peninsula forming the south-eastern boundary of Plover Cove. The crest of Tung Tau Chau itself will be cut down and surfaced with concrete to form the overflow spillway into the sea. Cofferdams will probably be formed across the subsidiary gaps before the main dam is closed, the remainder of the subsidiary dams (incorporating the cofferdams) being constructed in the dry. The subsidiary dams will be constructed of materials similar to those in the main dam.

The principal quantities of materials involved in the main and subsidiary dams will be:

Dredging	6½ million c. yd.
Decomposed rock	7½ million c. yd.
Rock fill	1¼ million c. yd.
Sand	2 million c. yd.

Instrumentation of the main dam will be a dominant feature of the works so that accurate information on the behaviour of the fill may be obtained as successive layers are placed, in order to preclude any possibility of a slide occurring due to an excessive build-up of pore pressures.

The tidal range in the area is about 8 ft. and so presents a problem in effecting closure of the inlet. This aspect of construction is the subject of extensive study in model tests at the Hydraulics Research Station, Wallingford, England. The tests seek to establish the best method for closure and to predict the currents likely to be experienced across and around the gap

Another problem which will require attention during construction is the limitation of pollution of the sea by the deposition of dredged clay and of fill materials. Special measures may have to be taken if it is found that fishing and oyster culture are affected.

Pumping out of the sea water from the newly formed reservoir will also form part of this contract. A temporary pumping station will be required to house the permanent pumps together with the additional pumps required for this purpose. Upon completion of the pumping out operation, the permanent pumps will be transferred to Tai Mei Tuk Pumping Station which is also included in the contract and comprises a reinforced concrete structure incorporating a pump sump founded on a rock outcrop in the bed of the reservoir and having an intake culvert extending into deeper water.

The abutments of all the three dams and, where necessary, parts of the perimeter of the completed reservoir will be sealed by grouting.

The results of extensive field and laboratory studies of the engineering problems involved will be made available to tenderers who will also be able to inspect many of the soil samples and rock cores taken. The contract period will be about five years, inluding pumping out of the reservoir and refilling to mean sea level.

This contract comprises of the main tunnel from Tai Po Tau to Plover Cove, complete with its four branch tunnels and the largest of the secondary tunnels, i.e., from Nam Chung to Plover Cove.

The main tunnel is about six miles long and has an equivalent internal diameter ranging from 26 ft. at Tai Po Tau to 30 ft. at Plover Cove ; the invert drops 13 ft. from Tai Po Tau to approximately low tide level at the Plover Cove portal. The spur tunnels, three of which extend to the south and one to the north of the Pat Sin Range, have a combined length of about three miles and connect up with a total of five stream intakes.

The Nam Chung Plover Cove tunnel has a stream intake at its northern end, is about 2½ miles long and has an equivalent internal diameter varying from 11 ft. to 14 ft.

The rock in which the main and branch tunnels will be driven is predominantly a volcanic of fhyolitic composition with sedimentary intercalations, weathering in places extending to considerable depth. Near Tai Po Tau, the main tunnel line enters granodiorite for about ½ mile of its length. The Nam Chung Plover Cove tunnel, after passing through conglomerates, sandstones, and shales, should also encounter the fhyolitic volcano. The main tunnel will be concrete-lined but concrete or mortar linings will be provided in the other tunnels only, where rock conditions or limited cover render them necessary.

(ii) *Eastern tunnels and catchwaters*

These are various tunnels ranging in equivalent diameter from 7½ to 14 ft. and totalling about 4½ miles in length which, together with short lengths of catchwaters, are located to the east of Plover Cove. These tunnels, which will be only partly lined, will be driven through formations similar to those on the Nam Chung Plover Cove Line.

Plover Cove Reservoir will have a useful storage capacity of 30,000 million gallons (110,000 acre ft.) out of the total storage of 39,000 million gallons (145,000 acre-ft.) and, with a length of 3¼ miles and breadth of about a mile, will cover 2,950 acres at its presently envisaged top water level. Possible future raising could increase the useful capacity by some 10,000 million gallons. Tai Mei Tuk Pumping Station will have an installed capacity or 100 million gallons perday with provision for running pairs of pumps in series when the reservoir level is very low and the pumping head exceeds about 25 ft.

But whatever may turn up, tourists will certainly have a new sight-seeing point at Plover Cove in 1968.

ADDRESSES OF CHAIRMEN AT THE ANNUAL GENERAL MEETINGS OF THE LOCAL CENTRES

Gujarat Centre

Chairman's address by Shri G. S. Desai, B.E., M.I.E., at the 6th Annual General Meeting of the Centre on January 9, 1966

The Chairman welcomed the Chief Guest Shri Nityanand Kanungo, Governor of Gujarat, and other invitees, and thanked the Committee of the Centre for electing him the Chairman for the year 1966.

Delivering the address, Shri Desai said, 'The State of Gujarat is broadly divided in two major divisions: the urban area and the rural area. The total area of Gujarat is 71,055 sq. miles. Out of this area, about 70,322 sq. miles cover rural Gujarat containing 18,584 villages, each with a population of 5,000 persons and less, vast areas of agricultural and waste lands, mountains, forests, rivers, ravines, etc. The urban areas of Gujarat comprise 733 sq. miles area consisting of towns of various categories as shown in Table 1.

According to the Indian census nomenclature, towns having less than 5,000 population are termed as villages. But, there are eight such villages in Gujarat which show more of urban activity than of the rural ones. Therefore, these villages are classed as class 6 towns. According to 1961 census, the total poulation of the State of Gujarat was 20,633,350, out of which 15,316,726 persons inhabited 18,584 villages in the rural area and 5,316,624 persons inhabited 175 towns and cities enumerated above. The pattern of population changes is shown in Tables 2 and 3.

Table 1

Population data of urban areas of Gujarat State

Category of town	Quantity	Names of important towns	Population range
Class 1	6	Ahmedabad, Surat, Baroda. Rajkot, Jamnagar, and Bhavnagar	100,000 and above
Class 2	10	Nadiad, Porbandar, Broach, Navsari, Patan, Cambay. Morvi, etc ,	50,000-99,999
Class 3	40	Surendranagar, Gondal, Anand, Bhuj, Balsar, Sidhpur, etc.,	20,000-49,999
Class 4	53	Deesa, Jambusar, Vadnagar, Dhandhuka, Himatnagar, Sihor, Dwarka, Dhari, Dakore, etc.,	10,000-19,999
Class 5	58	Dhrol, Kalol (Panch Mahal), Halvad, Vaso, Mundra, Dharmaj, Tharad, etc.,	5,000- 9,999
Class 6	8	——	Less than 5,000

Table 2

Pattern of population changes in Gujarat State

Area	Population in 1901	Population in 1961	Increase in population, %
Urban	2,030,738	5,316,624	61.8
Rural	7,064,010	15,316,726	216.8
Total	9,094,748	20,633,350	126.9

From the statistics, it becomes apparent that against a general rise in the population of State of Gujarat between 1901 and 1961, the growth in urban population is more than that in the rural population. The rise in population of class 1, class 2 and class 3 towns is much higher than the general rise of the population of the State of Gujarat. Whereas, the rise in population of class 4, class 5, class 6 towns and 18,584 villages is less than the general rise in the population of the State of Gujarat between 1901 and 1961. This

Table 3

Pattern of population changes in towns of different categories in Gujarat State

Category of town	Population in 1901	Population in 1961	Increase(+) or decrease (—) in population, %
Class 1	408,985	2,311,615	+465.2
Class 2	110,286	622,030	+464.0
Class 3	378,887	1,195,513	+215.5
Class 4	558,466	702,603	+ 25.8
Class 5	400,960	449,928	+ 12.2
Class 6	176,164	34,935	— 80.2

not only shows a very fast rate of urbanization in class 1, class 2, and class 3 towns, but, obvious stagnation in class 4, class 5, class 6 towns, and 18,584 villages.

There is no wonder that about 90% of industries in the State of Gujarat is concentrated in or near six class 1 cities and few of the class 2 and class 3 towns. Yet, many more public and private sector industries are coming up and are proposed near the 6, class 1 cities. Thus, 6 class 1 cities and a few of the class 2 and class 3 towns are growing at a dangerous rate. In fact, Ahmedabad is showing the signs of bursting. Rural population is coming to these growing industrial centres and rural area is being impoverished in direct proportion to the giant growth of the industrial city areas. It is apparent that the industrial areas are poisoning the rural areas in the sense that all non-agricultural industries in the form of cottage and small scale industries are being killed off by the city industries and the rural population migrating into the cities for employment create all sorts of problems for them. This mutual poisoning has to be stopped. The obvious way out is balanced regional growth of the country as a whole. It invokes the question of regional planning. The word 'regional planning' is much used nowadays without its implication being properly understood. Therefore, let us first be clear about the exact significance of the term of 'regional planning'.

Without straying too far from our subject, the objective of regional planning may be defined as 'the cultivation of habitability of the regions of human settlement'. The term 'habitable' may be defined as any natural or artificial space which provides man with suitable external conditions for his continuous existence, such as food, shelter, health, climate, different facilities, etc. Since the industrial revolution in England, the different cities and towns in the West, which were independently functioning as separate units, unconnected with each other, began to be getting more and more dependent and inter-related with each other. This process began to be disclosed only in the last decade of the 19th century. But the full implications of the regional planning as against the planning of an individual city or a town became obvious after the Second World War.

Unfortunately, there appears to be a lack of clear appreciation of the overall meaning of 'regional planning'. It is explained by the terms 'balanced and co-ordinated development of region'. To get clear conception and philosophy of regional planning, I find it necessary to trace some events in the prehistoric and historic periods to bring home the true concept of 'regional planning'. After the end of the 'period of Adam', the human race had entered the second period, which is known as "neolithic revolution." Here, the human intellect had to act in order to preserve natural and social equilibrium. From the stage of a savage, he has entered an era, when he learns the arts and method of producing and preserving food by farming and agriculture. He cultivates the land in small communities co-operatively. He maintains the natural balance by rational methods, and preserves the flow of biotic cycle : soil, water, plant, animal, man, which ensures permanent fertility of the earth and permanent livelihood for society. The earth served as the communal property of society and provided it with a secure livelihood, as long as society conformed to the laws of land and nature. The permanent fertility of the soil was the basic valuation criterion on which the social life and existence of settled peasantry were based. Society was co-operating with the land and was not owning or exploiting the land. Permanent fertility of land was preserved by obeying the rule of return. This rule was preserved by solving complex problems, like manuring, irrigation systems, etc.—in short, by planned use of land. For thousands of years, a social equilibrium and an equilibrium between society and earth were maintained. Such a society was maintained over the longest period of human history.

In one of the periods of history, the farmers began to desert the village when foreign nomad tribes made successful invasions into the regions of ancient settlement. The farmers became subservient to the new class of noble man, bureaucrats and merchants. These events thoroughly destroyed the stability and self-containment of ancient settlement. The social centre of gravity was transferred to the cities. On the one hand, man obtained powers to exceed the limitation set by nature and began to accumulate wealth in terms of 'money'. On the other hand, the land became more and more an object of exploitation and mining. There is no end to the accumulation of money, of deceptive wealth, but there is—as far as our capabilities go up to this day—quite a clear and fairly exact limit to the increase in the productivity of the soil. As a consequence the land has turned into waste lands and desert, some times by neglect, and at other time by excessive cultivation. The transformation of money into the main economic value signifies, therefore, a disregard for the fate of future generations and human existence. It endangers the only source of sustenance society had and has the fertility of the soil. One can exploit and misuse the earth and robe it of its fertility in the course of five years for the sake of quick profits, but a hundred years of preservation and rest will not fully restore the damage.

The final period in the development of social settlement structure is represented by the so-called capitalist period. In the previous period, the society in all their dynamic searches, experiments and innovation, at least, aspired for a renewed stability. But, in the final capitalist period, dynamism becomes an end in itself. The division of the society into mutually hostile classes, into disconnected professions, proceeds a pace and causes social fragmentation and amorphosness. The technical inventions and increase of mechanical power, the increased availability of raw materials imported from far-off regions to the countries where industrialiaztion makes progress and the unprecedented increase of population revolutionized the structure of human settlement. All this, brought about and encouraged indiscriminate exploitation of the agriculture and other natural resources of distant and spacious regions. The city's dependence on the neighbouring villages ceases, and many farmers are forced to become proletarians. They go to the growing unplanned cities to be absorbed in industries. Metropolitan centralism and backward rural area indicate the extreme inequality in the participation of population in the contemporary culture Thus developed the dynamic and progressive metropolitan centres at the expenses of the basic producers in large parts of the world.

This historical background was necessary to grasp the true significance of the term 'regional planning'. Opulent America, the rich urbanized West and impoverished Asian countries with their huge population problems are confronted by the same grave problem—of the lack of economic, social and human stability and equilibrium, and the absence of stability in contemporary settlement problems. Ninety percent of the people and towns of U.K. and more than seventy percent of the people and towns of the U.S.A. are urbanized. The standard of life in these countries is much higher than the same in the developing countries like India. Even then, there is growing recognition of perils to man and society inherent in the process of contemporary development in these highly developed countries. The contemporary emergency which calls for regional planning manifests in many ways, the most prominent being: (i) vanishing natural resources, and growing population pressure, i.e. absence of a favourable balance between society and natural resources of its sustenance, (ii) amorphization of social and land settlement structures, (iii) hostility between urban and rural areas, (iv) the strain of mechanization on living conditions, (v) deforestation and resulting deficiency in percolation and infiltration of surface water and consequent depletion of underground water, etc.

Regional planning is, thus, an attempt to pursue consciously and with rational means the development of habitability. It is primarily based on scientific and technical studies. The assumption underlying a regional planning is that man and society will decide to use the land according to the land's capabilities and for the preservation of its essential values, rather than robbing it for the sake of temporary profits.

With the foregoing description of the concept of regional planning, let us revert to our problem in Gujarat. About 30 class 1, class 2 and class 3 towns are showing phenomenal growth, due to industries being located there. 145 towns and 18,584 villages show the signs of stagnation, decay and obsolescence. Before it is too late, it is high time that our leaders grasp the significance of this phenomena. The vast agricultural population cannot subsist on 'agriculture' only, even if the agricultural production is materially increased. Rural non-agricultural production based on 'small scale' and 'cottage industries' will have to be planned So far, nothing is done to arrest the ruinous process of city and town expansion at the cost of rural area, though local town planning schemes are prepared in respect of few towns in isolation. Many unwarranted urban expansion are going on and are being proposed in isolation instead of working within the framework of properly conceived regional plan. Unplanned growth of big cities and towns is going on unabated on account of industrialization programme with its adverse effect on the rural area. It is heartening to note that the State Government of Gujarat has thought of incorporating 'regional concept' in the new draft for amending the Town planning Act of 1954. Let us hope the State Government of Gujarat blazes the trail and shows the way to save the country from gravitating to a slow but sure human tragedy.

In conclusion, I would fail in my duty if I miss to emphasize our urgent need of having our own building. At present, we are accommodated by the Gujarat Institute of Civil Engineers and Architects in its premises. We have made unsuccessful efforts with the State Government to get a piece of about 2,000 sq. yds. of land. If we get land, the Institution of Engineers (India) gives money for the structure. Many Centres in other states are fortunate in obtaining the land from their respective governments, but we have not met with similar luck. We again request the government to see its way to help us out.'

Kerala Centre

Chairman's address by Shri T. P. Kuttiammu, M.I.E., at the 19th Annual General Meeting of the Centre on March 5, 1966

After welcoming the Chief Guest, the experts who took part in the symposium on the 'Industrial Complex in Alwaye-Cochin Region', and other invitees, Shri Kuttiammu thanked the Committee of the Centre for re-electing him the Chairman for the ensuing year.

Delivering his address, Shri Kuttiammu said, 'The strength of the Institution has registered a further increase and at the end of the year it stood at 1295, 308 corporate members and 987 students. There is a scope and need for still further increase, for we should have on our rolls a large percentage of all those who are eligible for membership in Kerala, so that the institution will be fully representative and its usefulness will be broad based. On the construction side, we wanted to improve the accoustics of the Institution building, and an examination hall, effect substantial additions to furniture and fittings and secure sites for small buildings for the Paper Centres in other towns. Very little could be done due to the emergency. This year too, the conditions may not be very favourable. We shall, however, again try to make a start on all these and secure what best we can. The Paper Centre at Kundara has worked extremely well; a new Centre has been started at Alwaye.

The technical meetings of the Centres are held in cooperation with our sister associations of engineers in the P.W.D., Kerala State Electricity Board, etc. Last year, the Public Health Engineering Association also joined this family and we have had several meetings in Trivandrum, Quilon and elsewhere. We have been able to start Book Banks in the Engineering Colleges at Trivandrum and Trichur. Requests have come from other Engineering Institutions for similar aids and we have to work for it. We have been able to conduct a few symposia and to have some of the papers printed. The Student Chapter has been particularly active in studies, in technical discussions and in sports and recreation. We have to think of starting similar chapters in other Centres of Kerala. All these are extremely useful activities and have to be made more and more popular. This can be achieved only through the whole-hearted cooperation of all members and well wishers, which I am sure will continue to be available in an abundant measure.

In my address last year, I explained certain aspects of food production in Kerala. Our annual requirement of rice at present is about 21 lakh tonnes, which is steadily on the increase due to increasing population and may rise to about 32 lakh tonnes in the next fifteen years. Against this, our production is a little over 11 lakh tonnes. With an all out effort on all fronts like irrigation, land reclamation, improvement of agricultural practices, etc., we may be able to increase our production to about 20 lakh tonnes during the same period.

In our State the allotment of funds made for irrigation and allied works for the coming year will be larger than ever before. Minor irrigation has been made a separate branch in the P.W.D. and we have now one Executive Engineer solely in charge of minor irrigation in each District. The scope for land reclamation is tremendous and has been actually demonstrated on pilot schemes like Manalur Kole in Trichur, R. Block in Kuttanad, Bolachira in Quilon, etc. and has to be extended to cover wide areas in our *kayal* and marshy lands. Here again, funds are available and it is the privilege of the Engineers and Agriculturists to push through the investigation and design of economically feasible schemes.

The picture is not equally satisfactory in regard to medium and major projects. The outlay on these in the next 15 years should be about Rs. 100-120 crores. The misconception still persisting in certain circles that we need not give priority to medium and major projects, should be cleared. It is these projects that impound and conserve large quantities of water and it is the coverage given by these projects that insures scientific agriculture and land development. What has been done in Palghat and Trichur and in small pockets elsewhere can be done all over the State by implementing our major projects. Take for example Kallada irrigation project in the State, costing Rs. 13.28 crores. It will irrigate 130,000 acres of double crop paddy in Quilon district and will bring several other direct and indirect benefits. Kanjirapuzha and Kuriarkutty are excellent projects covering vast areas in the flat region of Palghat district. Chimmony and Muppily dams in Trichur will increase food production about two times in three years, if taken up for execution. Pazhassi and Kuttiadi cover about 70,000 acres in the coastal region of south Cannanore and north Kozhikode which are woefully poor in yield. The large canals of these projects connecting Taliparamba to Elathur in a net work will bring life giving waters to these fields and change their very face. All these have been delayed so long due to complete neglect of irrigation in Kerala in the pre-Plan period and due to pressing demands of power and other factors in the first three plans. We should at least now give irrigation a very high priority. Funds should be found to finance all these projects in the ensuing Five Year Plans.

Our efforts to get Central aid for anti-sea erosion works have succeeded. In Fourth Plan, these works are to be fully financed by the Central Government. Assured of such aid, we can now go ahead with the study of the coastal erosion problem in a systematic and scientific manner and secure permanent solutions. A Beach Erosion Board has been constituted with the Chairman of the Central Water and Power Commission, Government of India, as its head. It will be this Board that will initiate and guide the studies and the works.

The Union Government have also offered to give substantial assistance to the development of our Inland Waterways and Minor Ports. Works are now in progress all over the State and these will receive further momentum in the coming years.

The Research Station at Peechi has justified its establishment and earned for itself a creditable place among the Research Stations in India. It is high time that we start studies and research on problems concerning roads and buildings also.

These are some of the more important technical developments under irrigation and allied subjects with which I am directly concerned. The members of this Institution are, one and all, connected with similar works of development. Everywhere we are going forward, but we get the feeling that the progress should be more rapid and efficient. There are bottlenecks like lack of finance, shortage of foreign exchange, shortage of foodgrains and of power. Some of these are difficult to surmount quickly. But there are other obstacles which can be removed. The engineers along with other technical personnel do feel that they are not given sufficient encouragement and freedom to go ahead with developmental activities in efficient ways. Very often we come across obstacles, lack of understanding and lack of appreciation. We naturally feel frustrated and unhappy. A developing country cannot afford to neglect her engineers and technologists indefinitely.'

Madras Centre

Chairman's address by Shri N. Mahalingam, B.Sc., M.I.E., at the 43rd Annual General Meeting of the Centre on December 20, 1965

After welcoming the Chief Guest, Shri O. V. Alagesan, Union Minister of State for Petroleum and Chemicals, other distinguished guests, and invitees, Shri Mahalingam thanked the Committee of the Centre for re-electing him the Chairman for the ensuing year.

Delivering the Chairman's address Shri Mahalingam said, 'The Institution of Engineers (India) has been very fortunate in that Shri Alagesan, Union Minister of State for Petroleum and Chemicals, has kindly agreed to inaugurate the 43rd Annual Session of the Madras Centre. I have great pleasure in welcoming him and I convey my thanks for his agreeing to be with us today.

It is the misfortune of the engineering profession that, in spite of the remarkable development in industry that is taking place, a fitting recognition has not been accorded to it. At very few places only the top management is given to the members of the engineering profession and mostly they have to be satisfied with being the technical heads of the projects, while complex decisions of accepting or rejecting their recommendations are only done by the administrative officials who head the industrial concerns. Many a time it has been our feeling that after analyzing the detailed development of some industrial units we come to the conclusion that their failures have been due to either lack of proper co-ordination or due to want of expeditious decisions, or sometimes due to both, at the top level. Now that the Government of India has appointed an Administrative Reforms Commission, it is the fervent hope of the engineering profession that this body will recognize the necessity to associate the technical personnel in administrative posts. Shri C. Subramaniam, Union Minister for Food and Agriculture, had stressed the necessity of giving more powers to the technical heads, while he was in the Steel Ministry. He has reiterated this opinion even with regard to the problems in the Food Ministry. We do hope, Sir, that you will consider favourably the chances of associating the technical personnel for top management in your Ministry.

Another important point on which I wish to draw your attention about the profession is regarding the position of civil engineers in most of the industrial complexes. We find both at Neyveli and at the Heavy Engineering Project at Ranchi that there is heavy retrenchment of civil engineers. Unfortunately the period of employment covered is nearly a decade and it is too late for most of them to make a fresh beginning in other places. May I suggest to the Union Government through the Honourable Minister that this problem has to be considered at a humane level and proper remedies be devised for the same? Our suggestion will be that all civil construction work, undertaken in various projects by the Union Government, may be done directly by the Central Public Works Department. Alternatively, all the civil engineers working in various projects may be given a ranking in the Central Public Works Department, and all permanent vacancies may be filled out of the redundant personnel from the projects. The problem is getting acute in view of the stress on defence being given priority in the Fourth Plan, and so most of the other projects are likely to be slowed down causing greater hardship for the civil engineers.

A matter which needs great attention at the all India level is the problem of 'urban housing'. The housing schemes undertaken by the Government involve the employment of manpower on a large scale. Thus, in the wake of increasing additions to the housing colonies, slums are also created side by side. Apart from this, the rate of progress of construction is also slow. On the other hand, in Western countries, house building has been mechanized to a great extent and many standardized parts are manufactured in factories and just like machinery is assembled, a multistoreyed building could be assembled with the assistance of a limited number of workers. The system that is being adopted in the West paves the way for the provision of houses at a fast rate and avoids the creation of new slums. It is essential for the Government and the civil engineering organizations to consider this matter to arrive at an agreed decision so that during the course of urbanization, additional slums are not created in our cities.

Another equally important matter which has to be considered by both the Centre and States is, the need for the educational authorities to properly forecast the demand for technical manpower during the next decade and to arrange their curriculum and courses of studies in all the technical institutions in the country in such a way as to suit the future need and demand. At present about 40% of the trained engineers are mostly on the civil side and we see, especially in Madras, that while the civil engineers are in surplus, they are not able to get proper employment opportunities commensurate with their qualification and training. So, it has to be examined whether it is essential to reduce the number of civil engineering students or to suitably alter the civil engineering degree and diploma courses so that they may be enabled to seek their future in other allied industrial vocations In view of the fact, that the problems of management are day-by-day increasing and the regulations in the safety techniques, and the rights of labour are continuously changing, it is essential that the technical personnel are provided with the basic minimum knowledge regarding management technique and labour laws. The appointments in the managerial category require all this knowledge and it is better to provide them for the young men during the course of their academic career rather than allow them to learn these after taking up employment.

National Emergency has made everyone of us to stress on more production. Production in the farm as well as in the firm depends upon two main factors, *viz.*, power and technique. In this country, the motive power for the farm is mainly oil, as the extension of village electrification has been slow. Better farm production needs tractors, bulldozers, sprayers, pumps, etc., all of which need oil. The present price of Diesel oil in India is very high due to the excise duty and sales tax levied by the Central and the State Governments. Thus the high price of oil has rendered the use of mechanical equipment in agriculture very uneconomical. From 1958, when the Centre introduced excise duty on a large scale for oil, many Members of Parliament have been stressing the need to provide oil at a cheap rate for agricultural use and the point was conceded in principle, but till now no workable arrangement has been devised for providing motive-power for agriculture at economical prices. Unless it is done, any amount of discussion and speeches on greater production will not yield the desired results. The main obstacle in the way of reduction in oil prices appears to be that the transport industry consumes nearly two-thirds of the oil in the country. This can be easily solved by increasing the vehicle tax on buses and lorries, so that the concession given by reduction in oil prices may be amply compensated for the exchequer.

I have only tried to highlight some of the important points which occurred to me to be considered at the policy-making level, so that our esteemed guest may give some thought to them and convey the same to his colleagues at the Centre for their consideration to be tackled at a national level.'

Summaries of Papers Published in the Journal, vol. 46, no. 10, pts. EL 5, CH 3 and PH 3, June 1966

ELECTRICAL ENGINEERING DIVISION

A Distortion Eliminator cum Distortion Analyzer for Power Frequency Mains Supply

Prof. J. K. Choudhury
Associate Member
and
D. P. Chakravarty
Associate Member

Alternating current commercial supply voltages contain some distortion; the distortion content generally lies between 4.8%. This amount of distortion is considered to be tolerable for most industrial and domestic applications. However, a distorted supply of this nature is unsuitable for precision electrical measurement purposes. In electrical measurement laboratories, it is necessary to have a power frequency supply source of negligible distortion. To meet this requirement, it is customary for electrical measurements and standardizing laboratories to install a special sine wave alternator together with its driving motor and control accessories. These equipment are expensive and are beyond the scope of small testing laboratories. This paper describes a simple and inexpensive equipment which can eliminate three principal harmonics, say, the third, fifth, and the seventh harmonics, from a commercial 50-cycles supply source and thereby give an output supply voltage having a distortion content less than 1%. The same equipment can also be used for measuring the total harmonic content of the commercial supply voltage and can thus serve as a distortion analyzer for the main supply.

Transient Reversal of Under-Rated Low Inertia Single-Phase Squirrel Cage Induction Motors

Dr. A. K. Das Gupta
Associate Member

This paper explains the possibility of reversing an under-rated low inertia, single-phase squirrel cage induction motor by reversing the supply voltage at the terminals of the motor. It also presents the experimental results to establish the possibility of obtaining such reversal of the motor under similar conditions.

Application of the Monte Carlo Method for the Evaluation of the Transfer and Driving-Point Admittance of a System

Dr. S. Das Gupta
Associate Member
and
A. K. Roy
Non-member

This paper presents the application of Monte Carlo methods in the analysis of electric circuits, both A.C. and D.C., in which the games were played noting average scores for the different variables posing as players of the games. This method shows how the circuit analysis can be approximately made. The accuracy of the result is then further improved by the customary iterative methods. This method has been employed to obtain the transfer of driving-point admittance of a given electric network.

Application of the Monte Carlo Games in the Analysis of A.C. Network—2

Dr. S. Das Gupta
Associate Member
and
A. K. Roy
Non-member

The condition to be satisfied for the use of Monte Carlo games in the network analysis is $\sum_{j=1}^{n} h_{ij} < 1$, for all values of i. This condition may not always be satisfied by the matrix to be inverted. This paper presents a method for the solution of such problems requiring the inversion of matrices which do not directly satisfy the above condition. This method may also be applied with equal advantage in the case of a D.C. network under the above circumstances. It also gives the solution of an example of an A.C. electric mesh network. The matrix inverted by this method gives an accuracy within 2.5% in most of the elements and only in case of one element the accuracy is within 4%.

A Review of the Present Status of Solar Energy Utilization

V. K. Maitreya
Non-member

Solar energy can be employed economically in several domestic appliances. In areas where fuel energy is highly expensive, solar energy may prove to be an excellent, easily available substitute. The conversion of solar energy to mechanical energy involves high cost, because unlike aeolian energy this energy is primarily in light or thermal form. This paper reviews the present state of development in solar energy utilization and stresses that it is essential to continue the efforts for progress in this field.

A Proposed Method for Representing Circuit Elements for Power System Fault Study in A.C. Network Calculator

S. R. Sikdar

Associate Member

The complexity of present day power systems compels us to solve the fault and other power system problems either by D.C. or A.C. network calculator or diginal computer. Due to its limitations in representing the power system, the accuracy of solutions obtained from D.C. calculator is poor and therefore the A.C. network analyzer is used by most of the utilities. This paper presents a new method for representing the circuit elements in A.C. network analyzer and gives the solution of a circuit with only one generator.

Steady State Heating of Induction Motors under Unbalanced Conditions

Prof. S. Srinivasan

Associate Member

This paper develops a thermal equivalent circuit and a method for the calculation of the temperature rise of a wound rotor induction motor, when the motor operates under steady state unbalanced conditions. The method has also been verified by applying it to a 5 h.p., 220 volts, 3-phase induction motor.

Electrical Insulating Oxide Films on Aluminium

Prof. B. M. Tareev

Non-member

Electrochemical oxidation can generate dielectric oxide films on aluminium and some other metals. This paper presents a classification of such films and describes the properties and applications of oxide films pertaining to the first and second classes. Aluminium electrolytic capacitors are very widely used. Electrochemical oxidation by direct (rectified) current is used at present for the formation of anodic aluminium foil, *e.g.*, generation of dielectric oxide film of the first class on its surface in mass production of electrolytic capacitors. The possibility of alternating current application for anodic foil formation is shown both theoretically and by experiments in laboratory and at plant as well. This fact considerably increases the operating efficiency of formation assemblies and provides some other advantages. The manufacture and use of anodizers, i.e., with second class oxide insulation, aluminium may also be very prospective for the Indian industry.

Studies on Failure of Distribution Transformers

A. Venkateswara Rao

Associate Member

This paper presents a brief analysis of the possible causes of failure of distribution transformers and also gives an exhaustive trouble-shooting chart for transformers and the associated switchgear.

CHEMICAL ENGINEERING DIVISION

Recovery of Potassium Salts from Spent Wash of Molasses Distillery

B. N. Chakrabarty

Non-member

and

T. R. Bhaskaran

Non-member

Since the establishment of distilleries in India, satisfactory disposal of their liquid wastes had remained a difficult problem. There are about thirty installations in the country and more than one-half of them are located in the State of Uttar Pradesh only. Most of these distilleries process cane sugar molasses obtained from sugar factories for production of ethyl alcohol, and only a small fraction of them use barley, rye, etc. to produce potable liquor. This paper presents the results of pilot plant investigations, which reveal that high grade potassium salts can be economically recovered from the molasses spent wash of the distilleries. The recovery process would also result in a satisfactory solution of the difficult disposal problem of distillery works in India.

Silicone Adhesives and Sealants

T. J. Gair

Non-member

This paper presents the properties of silicone adhesives and sealants, and describes the versatile range of their applications in the technical enterprises.

Theoretical Evaluation of Thermodynamic Properties of Freon Refrigerants

L. N. Misra

Non-member

This paper deals with the principle of the theoretical evaluation of thermodynamic properties of Freon Refrigerants and calculates the properties of both Freon 12 (Dichloro difluoromethane) and Freon 11 (trichloro monofluoro methane). The properties of Freon 12 thus calculated have been compared with the values given in the data book published by the American Society of Heating, Refrigeration, and Air-Conditioning Engineers. The properties of Freon 11, as calculated, have been given in a tabular form over a wide range. A pressure-enthalpy chart and an enthalpy-entropy chart for Freon 11 have also been developed, which will be useful for Freon turbine designers and refrigeration engineers.

PUBLIC HEALTH ENGINEERING DIVISION

Studies on Effluents from Pulp-Paper Mills and its Role in Bringing the Physico-Chemical Changes around Several Discharge Points in the Hooghly Estuary

A. K. Basu

Non-member

The pollution load contributed by effluents of the major pulp-paper mills situated in and around the Hooghly estuary was estimated as 40,040 lb. per day B.O.D., 322,820 lb. per day suspended solids, and 54,210 lb. per day of lignins. The B.O.D. values of the effluents when computed in terms of untreated sewage gives the 'population equivalent' as 235,529. The physicho-chemical conditions in the close vicinity of discharge points of the effluents indicated that they were not satisfactory. But owing to tidal mixing, flow, and large volume of mixing water the immediate effects of pollution arising out of the pulp-paper mill effluents on the receiving water were negligible.

Seasonal and Diurnal Fluctuations in Water Consumption

J. K. Bewtra

Non-member

Three years data on hourly and daily water consumption in seven distribution districts of Delhi were analyzed to obtain design factors for distribution mains and distribution reservoirs. These districts have 24-hour supply with throttled supply in the night hours in some districts and were so chosen as to cover the population with different standards of living and with varying proportion of domestic, industrial and commercial use. This paper presents the maximum and minimum daily demand, peak hourly demand and effective equalizing storage values along with their periods of occurrences. A rising main connecting the two distribution reservoirs has also been studied.

Application of B.O.D. Moderator for the Treatment of Pharmaceutical Wastes

B. V. Kadam

Non-member

and

K. M. Wani

Non-member

Proper sanitary disposal of liquid wastes, particularly industrial wastes, has proved a difficult problem all over India for want of suitable method of treatment. The cost of building and running a small purification plant of conventional design is comparatively very high. This paper presents the results obtained by the application of a B.O.D. moderator for treating pharmaceutical wastes from an industry in Gujarat State.

Role of Compost Plants in India as Urban Amenity and as a Source of Organic Fertilizer

T. R. Krishna Rao

Non-member

Compost is an organic fertilizer and soil conditioner, produced using city and town refuse as raw material. Night soil and sewage sludge can be added to the refuse to increase the amount of compost produced and also enrich its contents. Compost is not new to the Indian farmers; it has been in use in India for quite sometime. However, its production is not in any way organized on a planned and national basis, and its use has not been made as significant a contribution as could be made, due to the small scale of production and use. This paper presents a brief analysis of the versatility of compost and stresses its importance in solving India's problems of food and agriculture.

Maintenance of Hand Pumps Fitted to Small Diameter Tube Wells in Rural Areas

N. Majumder

Member

and

S. Subba Rao

Associate Member

Based on experience gained in the Singur Health and Training Centre, West Bengal, the authors present in this paper the maintenance requirements of hand-pumps installed in rural areas for water supply. It is observed that the operations involved in surging and re-sinking of tubewells are comparable with those of sinking new tubewells, and it is, therefore, found convenient to link up the programme of surging a re-sinking of tubewells with that of sinking new tubewells.

Oxidation Ponds for Vijayawada in Andhra Pradesh

Y. S. Murty

Associate Member

R. R. Harris

Non-member

M. Govindiah

Non-member

and

G. K. Seth

Non-member

Extensive laboratory and pilot plant studies have indicated the great potentialities of oxidation ponds as sewage treatment facilities in India, especially in Andhra Pradesh. Based on results of these studies, a full-scale treatment plant is being constructed in Andhra Pradesh for the first time at Vijayawada to get 6 million gallons per day of partially treated sewage and 1 million gallons per day of septic sullage in separate oxidation ponds located at different parts of town. This paper presents the factors which have weighed in favour of oxidation ponds, together with the complete design and cost analysis of the project.

A Simplified Sewage Purification Process for Small Quantities of Domestic Sewage and Industrial Wastes

C. J. Shah

Associate Member

Industrial expansion together with the concentration of large population in certain developing towns and villages has created serious problems of stream pollution, and incidental pollution of water supply sources. Sewage disposal has, therefore, become a live problem all over India. The costly conventional sewage treatment plants cannot be adopted as and where required, mainly because of shortage of funds, and non-availability of plants without foreign exchange. This paper presents the details of an effort, made at Baroda, to work out under Indian conditions a process by which small quantity of sewage can be purified at such a cost that the process may find general adoption. The mechanism required is very simple, can be locally fabricated and does not require any skilled supervision.

Use of Nomographs for Quick Design of Sewage Treatment Plants

S. Subba Rao

Associate Member

Several authors have published in various journals, a number of nomographs to facilitate quick design of various units used in the treatment of water and sewage. Although designs can be made with the basic equations involved, the nomographs come in very handy for a busy design engineer for whom at times, time factor becomes a primary consideration. Particularly now and in future, when a large number of water supply and sanitation projects are going to be envisaged throughout India under the national and state water supply and sanitation programmes, engineers may find such graphs very useful. For purposes of convenience, these nomographs are classified under two main groups, namely, sewage and water, and those useful for sewage treatment are compiled and presented in this paper with illustrative examples to show how these graphs are used.

PROCEEDINGS OF THE MEETING OF CORPORATE MEMBERS, PATNA, JANUARY 30, 1966

A meeting of Corporate Members was held on Sunday, 30th January, 1966, at the Bihar Centre of the Institution, Hardinge Road, Patna, at 12.05, to consider the formation of 'The Benevolent Fund of the Institution of Engineers (India).' In the absence of Prof. N. S. Govinda Rao, President, Shri B. P. Kapadia, President-Elect, was in the Chair, as the seniormost member of the Council; there were 253 Corporate Members present.

The President-Elect at the outset wanted to postpone this item as he had certain views against this item and in the absence of Prof. N. S. Govinda Rao, he would not like to take up this item, but would like to postpone it. However, some members desired that this should be taken up in that meeting only.

The President-Elect stated that the Institution should *not* do certain things which bring down the name of the Institution. He felt that this is one of such items which will produce *no result* and therefore, we shall be subject to direct criticism all round. Further, he quoted that more than 6 or 7 years ago a 'Rupee Fund' was started for establishing scholarships for engineering. This was perhaps a better objective than this Benevolent Fund and was really an excellent idea; he added that the members will be surprised to note that after 7 years only Rs. 700 to Rs. 800 have been collected. A worse fate might result in this as times are more hard and difficult than before. He, therefore, expressed that this item may be withdrawn.

However, some members did not agree to it.

Next, Dr. T. Sen proposed that 'The Benevolent Fund of the Institution of Engineers (India)' be formed, and that the Memorandum of Association of the Benevolent Fund and the Rules and Regulations of the Fund as shown in the Annexe to the Notice be adopted, with, however a suggestion as made by the Council to the legal advisers to make the necessary addition to the rules in order that the Controller of Accounts of the Institution may be the *ex-officio* Secretary of the Fund, and modifications, if any, for purposes of income-tax exemption.

Maj.-Gen. Harkirat Singh seconded the proposal of Dr. Sen. This was passed.

With a vote of thanks to the Chair, the Meeting terminated at 12.30 p.m.

INSTITUTION NOTICES

Draft Indian Standards

The following draft, Indian Standards have been issued recently.

1. Draft Indian Standard Methods of Test for Soils: Part 1—Preparation of Dry Soil Samples for various Tests—Doc.: BDC 23 (868); Part 20—Determination of Dry Density of Soils *in-situ* by Sand Replacement Method—

Doc: BDC 23 (937); Part 27—Determination of Calcium Carbonate—Doc: BDC 23 (1085) and Part 28—Determination of Dry Density of Soils in place by the Core Cutter Method—Doc: BDC 23 (1129).

Part 1 of the standard covers the method of preparation of dry samples from the bulk soil sample received from the field for various tests. Part 20 covers the determination, *in-situ* of the dry density (weight of dry soil per cu. cm. or cu. m.) of compacted fine and medium grained soils. Part 27, lays down the method for determining the percentage by weight of the content of calcium carbonate in soil. Part 28 covers the determination *in-situ* of the dry density weight of the dry soil (per cu. cm. or cu. m.) of natural or compacted soil, but it is recommended that it should be used only when it is not possible to use the methods of Parts 1 and 20.

Members may send their comments on this draft Standard before July 15, 1966, to Shri C. G. Swaminathan (*A.M.*), Assistant Director, Central Road Research Institute, New Delhi 20, who is the Institution representative on the Sectional Committee dealing with this draft Standard.

2. Draft Indian Standard for Fire Resistance Test of Structures—Doc: BDC 36 (888).

This standard lays down the method of test for determining fire resistance property of built up elements of building structures and enables grading of these elements according to their ability to resist fire.

3. Draft Indian Standard for Method of Test for Combustibility of Building Materials—Doc: BDC 36 (889).

This standard lays down the method of test for determining the combustibility property of building materials.

4. Draft Indian Standard for Fire Propagation Test—Doc: BDC 36 (920).

This standard lays down a method of test for measuring the ignitability of combustible materials and the contribution they can make to grow of fire in buildings.

Members may send their comments on these draft Standards before July 15, 1966, to Brig. N. B. Grant (*M*), Director (Engineering), R & D, Ministry of Defence, Kashmir House, New Delhi 11, who is the Institution representative on the Sectional Committees dealing with these Standards.

5. Draft Indian Standard Specification for Foot Valves for Water Works Purposes—Doc: BDC 3 (1012).

This standard covers the requirements for flanged and screwed-end foot valves of both swing and lift types for use with centrifugal pumps for water works purposes.

6. Draft Indian Standard Specification for Surface Boxes for Sluice Valves—Doc: BDC 3 (1056).

This standard lays down the requirements for cast iron surface boxes for use with sluice valves for use on service pipes and water mains.

Members may send their comments on these draft Standards before July 20, 1966, to Shri B. B. Rau (*A.M.*), Deputy Assistant Director General (Public Health Engineering), Central Public Health Engineering Organization, Wing 8, Patiala House Annexe, Tilak Marg, New Delhi 1, who is the Institution representative on the Sectional Committee dealing with these Standards.

Copies of the draft Standards may be obtained from the office of Indian Standards Institution, 'Manak Bhavan', 9 Bahadur Shah Zafar Marg, New Delhi 1, or from its branch offices at Bombay Mutual Terrace, Sandhurst Bridge, Bombay 7; 5 Chowringhee Approach, Calcutta 13, 14/69 Civil Lines, Kanpur. or 54 General Patters Road, Madras 2.

Central Roster of Scientific Translators

The Indian National Scientific Documentation Centre (Insdoc) is compiling a Central Roster of Scientific Translators. Persons possessing scientific qualifications and proficiency in any of the foreign languages except English will be enrolled in the Roster, with a view to utilizing their spare time in activities which are very useful to the nation and to themselves. Further particulars can be obtained from the Director, Insdoc, Hillside Road, Delhi 12.

INSTITUTION NEWS

President's Itinerary

Shri B. P. Kapadia, President (1966-67), left India on May 6, 1966, for the U.K. to participate in the Sixth Meeting of the Conference of the Engineering Institutions of the British Commonwealth, held in London from May 9-20, 1966. In London, he was joined by Shri R. N. Banerjee, Secretary, who had left India on May 4, 1966. On the successful completion of the Meeting, the Secretary returned to India and joined office on June 2. The President is expected to be back in India on June 25, after an extensive tour of the various engineering projects all over the Continent.

Like the earlier five meetings held in London (September 1946), Johannesburg (April 1950), London (May 1954), Australia and New Zealand (March 1958) and Canada (September 1962), this meeting provided a forum for free exchange of views among the Presidents and Secretaries of the participating institutions, the details of which will be published later.

USE OF FLY ASH IN BUILDING INDUSTRY

This monograph on 'Use of Fly Ash in Building Industry' is the outcome of the approval given by the Council of the Institution at its 435th Meeting held in Bangalore on May 23, 1964, to a resolution moved by the Chairman of the Civil Engineering Division.

The contents of this monograph highlighting the features of the highly versatile building material, fly ash—an industrial waste produced in profusion in the thermal stations of India and difficult of disposal as produced—which was the subject of investigations by a research team at the Central Building Research Institute, Roorkee, was approved by the Council for publication in its present form.

The cost of the monograph is Rs. 2.30 and orders, accompanied with payment by postal order or cheque, may be addressed to the Assistant Secretary (Technical) at the Headquarters office.

Prof. R. N. Banerjee—the new Secretary

Prof. Ramendra Nath Banerjee, B.E. (Elec.), M.S. (Mech.) (U.S.A.), M.Tex.A. (India), M.I.E. the new Secretary of the Institution, was born in Calcutta in 1914.

He passed the Matriculation Examination from the Calcutta University in 1930 securing first grade Scholarship and Gold medal. He passed the B.E. in Electrical Engineering from the Bengal Engineering College, Sibpur, in 1936, standing First in order of merit with First Class Honours, securing the University Gold Medal, prize and the Siebley Scholarship. Incidentally, he is the first Electrical Engineering graduate from the Calcutta University.

Prof. Banerjee then joined the Tata Iron and Steel Co. Ltd. as an A-Class apprentice and passed the Technical Graduateship Examination in Metallurgy and Higher Engineering from the Jamshedpur Technical Institute. In 1938, he was selected by the Government of India as a Machinery Expert Appraiser for his specialized knowledge of Iron and Steel Industry and was posted in the Calcutta Customs. During the first part of the last World War, he was sent on special deputation to Chittagong and Karachi ports and then to the Indian Stores Department in Calcutta. In 1946, he was sent by the Government of India to the University of Minnesota, U.S.A. for higher study and training in Refrigeration and Air-conditioning. There he took his M.S. degree in Mechanical Engineering and worked for about a year in several factories as a Refrigerating Engineer. After his return in 1948, his services were requisitioned by the Government of West Bengal. He was kept for a year in the Electrical Engineering Department of the B.E. College and was then placed in-charge of the Government Cold-storage and Ice Plant as a Resident Engineer, and also as a Visiting Lecturer in the M.E. Department of the B.E. College. In December 1950, he joined the newly founded Institute of Jute Technology of the Calcutta University as the Professor and Head of the Engineering Department and subsequently became its Principal in 1956, which post he was holding up till now. Here he introduced a new line of post-graduate technical instruction incorporating the Industry and the University together.

Prof. Banerjee has a long association with the Institution starting as a Student member in 1935. He was elected an Associate Member in 1943 and a Member in 1954. He was the Honorary Secretary of the Bengal Centre for three years in 1954, 1955 and 1958; a member of the Council for six years in 1955-56 and from 1958-63; and a member of the Finance Committee for one year in 1955-56. He was appointed by the Council as the Convenor of the Students Welfare Sub-Committee. He was the Chairman of the Students Welfare Sub-Committee of the Bengal Centre for seven years. Up till now, he was representing the Bengal Centre in the West Bengal Electrical Licensing Board, and the Institution in the Indian Standards Institution's Calcutta Branch Office Advisory Committee. It was he who in 1954, first introduced the system of regular weekly meetings, framed the Division-wise Advisory Committee for fixing up programme and established the properly constituted Students' Chapter in Bengal Centre. He also convened the first meeting of the Honorary Secretaries of the Local Centres at the time of that year's Annual General Meeting, for better inter-Centre co-operation and co-ordination. He has conducted Refresher Courses, delivered lectures and contributed many technical papers in the seminars and symposia of this Institution. He has also contributed an article in the Mechanical Engineering Section of the Review of Engineering Developments, published by the Institution. He has also contributed papers and delivered lectures in the Indian Science Congress, Indian Textile Association, A.S.M.E. (Minnesota, U.S.A.), All India Radio, B.B.C. (London), Rotary Clubs, Y.M.C.A., etc. in this country and abroad.

He was the Vice-President and then President of the Calcutta Branch of th Textile Association of India. Upto the present, he was the Honorary Secretary of the Eastern Zone of the Association of Principals of Technical Institutions, Association of Plant Executives (India), and the B.E. College Alumni Congress.

He was a Member of the Iron and Steel Institute (London), American Society of Refrigerating Engineers and the American Society of Mechanical Engineers.

In his college days, he was a first-rate sportsman, taking part in all important games. Now in his leisure time, he indulges in drama, music and outing.

LOCAL CENTRE ACTIVITIES

Visit of the Minister for Labour, Housing and Transport, Government of Mysore, to the Engineering Research, Development and Consultancy Centre

Shri Devaraj Urs, Minister for Labour, Housing and Transport, Government of Mysore, paid a visit to the Engineering Research, Development and Consultancy Centre, Bangalore, on April 11, 1966. The Minister had a frank discussion on the subject of training facilities for various trades in the building industry. Shri B. L. Shantamallappa, Director of Technical Education, Shri R. Sampathkumaran, Director of Training and Employment, Shri R. A. Rajagopal and Col. A. Ramaswamy were also present.

Shri I. M. Magdum, Chairman of the Mysore Centre, described the background on the growing importance of trained personnel and their acute shortage in the building industry for which emphasis has been given in the Fourth Five Year Plan. With a view to achieving greater productivity in the context of shortages of essential building materials, he said, the Mysore Centre of the Institution felt the importance for starting the training schemes and hence prepared a scheme with a syllabus for various trades required for the building industry for a course lasting three months and submitted the scheme to the Director of Training and Employment for due recognition of the course and necessary further assistance. The scheme has, however, not yet been approved.

Then Shri R. Sampathkumaran explained the difficulties in getting the scheme approved by the Government.

The Honourable Minister appreciated the initiative of the Mysore Centre. He agreed that there was an acute shortage of trained men and with the prgoramme of heavy outlay on the building construction activity, a large force of trained men would be required in the Fourth Plan to achieve the targets laid down.

Shri Shantamallappa said that while they could impart the theoretical instruction for the sponsored candidates with the staff at their disposal, subject to the approval of the Government, the practical demonstrations have to be done at works sites which are out of their means. Col. Ramaswamy offered to spare the services of some instructors, if necessary, in the initial stages. He also said that the Contractors Association would be able to sponsor their own employees for further qualification and training so that they could fit in the industry properly and could be used further for training newcomers. At the suggestion of the Minister, it was decided that the Director of Training and Employment may consult the Director-General of Training at the Central Government and take up the training scheme for the various trades. It was also decided that such training schemes may for the present be introduced in one or two places in the State, in cooperation with the various wings of P.W.D., Housing Boards and certain other Private organizations such as the Mysore State Contractors Association.

FORTHCOMING EVENTS

Symposium on Automation, Bucharest, October 6-8, 1966

A Symposium on 'Automation' will be held in Bucharest, Rumania, from October 6-8, 1966. Sponsored by the Commission for Automation of the Academy of the Socialist Republic of Rumania, the symposium will deal with the topics given below :

(i) General theory of linear, non-linear, sequential, optimal, numerical systems, criteria for evaluating the systems ; behaviour, etc.'

(ii) Component elements : numerical, analogical elements, elements for static swiching, characteristics of elements in automatic systems, etc. ;

(iii) Industrial applications: Dynamics of industrial process; utilization of computers for guiding industrial processes; applications of adaptive and optimal systems;

(iv) Utilization of computers: in transport, management, finance, etc.; technical and economic results of computer's use, etc.;

(v) Telemechanics: general theory, equipment, applications, etc.

Further details can be obtained from Dr. Eng. Aurel Avramescu, Chairman of the Commission for Automation, Academia Republicii Socialiste Romania, stn. Gutenberg nr. 3 bis, Bucuresti, Rumania.

International Congress on 'Distribution and Town Planning, Brussels, November 14-18, 1966

The Belgian Federation for Housing, Development and Planning is organizing an International Congress on 'Distribution and Town Planning' to be held in Brussels from November 14-18, 1966. The Congress will give the participants an opportunity to exchange their points of view regarding the requirements of distribution with respect to town planning. The technical sessions include (i) Consumption and distribution, (ii) Distribution in the outskirts of towns and in the new towns, (iii) Distribution and town and country planning, (iv) Ditstribution and urban renewal, (v) The future of cities, (vi) Distribution and Regional Planning, (vii) Formal closing session, and synthesis and conclusions.

Further details can be obtained from Federation belge pour l'urbanisme et l'habitation, le development de tervitoire, 61 rue Montoyer, Bruxells, 4, Belgium.

Southeast Asian Regional Conference on Soil Engineering, Bangkok, April 24-29, 1967

The SEATO Graduate School of Engineering announces the sponsorship of a Southeast Asian Regional Conference on Soil Engineering to be held in Bangkok, Thailand, from April 24-29, 1967. The primary objectives of the Conference are to stimulate interest in the science of soil engineering amongst engineers in Southeast Asia, to promote the advancement of soil engineering in the region, and to provide an opportunity for engineers, researchers, and educators in the profession: (i) to exchange ideas and experiences, (ii) to discuss particular problems of the region, and (iii) to reveal and discuss research in soils with particular emphasis on the regional aspect.

Further information can be obtained from Dr. Za-Chieh Moh, Chairman, Conference Committee, SEATO Graduate School of Engineering, P.O. Box 2754, Bangkok, Thailand.

Scrap and Wastes Exhibition, Olympia, London, July 17-21, 1967

The first 'Scrap and Waste Exhibition' will be held at Olympia, London, from July 17-21, 1967. With the increasing demand for manufacturing materials, the world's supplies of raw materials are rising in price and becoming scarce. It is essential, therefore, that the most modern techniques for recovering, handling, sorting, processing and re-manufacturing of waste materials should be applied to conserve the resources available. Organized by Industrial Presentation Ltd., London, the theme of the exhibition will be 'Reclaimed Prosperity'.

Further details can be obtained from the organizers, Industrial Presentation Ltd., 64 Pembroke Road, London, W.8.

BOOK ACKNOWLEDGMENTS

1. **Research Publications and Theses of Roorkee University.** R. S. Saxena and S. Gupta. *Nemchand and Bros.*, Roorkee. 1965. 124 pages.

In this book, the bibliography of research publications and theses of Roorkee University from July 1960 to July 1964, have been compiled by the authors. The publication of this type helps in coordinating and using the results of researches in industry and technology; and also helps in avoiding the duplication of research-work.

2. **Workshop Technology.** G. S. Gaire. *Prakash Brothers,* Ludhiana. Rs. 5.50, 1966. 84 pages.

This book is mainly intended for the second year diploma and second year degree students of engineering. It deals with ferrous and non-ferrous metals and other materials, heat treatment of metals, foundry, forging, soft soldering, brazing and welding, lathe machine, and drilling machine.

3. **Laboratory and Workshop Notes. 1962-64.** Ruth Lang (Ed.) *Edward Arnold (Publishers) Ltd.*, London. 60s., 1965. 278 pages.

This book contains reprints of papers published in the *Journal of Scientific Instruments,* and is compiled for the Institute of Physics and the Physical Society. These selected laboratory and workshop notes which cover three volumes of Scientific Instruments, are very useful for the laboratory and factory workers. The book is divided in seven sections, *viz.*, laboratory and workshop devices and techniques, optical devices and techniques, thermal devices and techniques for use with liquids and gases, devices and techniques for low temperature work, vacuum and pressure devices and techniques, and electrical and electronic devices and techniques.

4. **Strength of Materials and Theory of Structures—Part 1.** S. C. Goyal and B. C. Punmia. *Central Publishing House,* Jodhpur, Rs. 15.50, 1964. 529 pages.

This book, written in metric system of units, is mainly intended for degree and diploma engineering students. The authors have tried to present the subject matter which lays emphasis on the fundamentals. Solved examples and unsolved problems with answers have also been included

5. **Strength of Materials and Theory of Structures—Part 2.** S. C. Goyal, B. C. Punmia, and O. P. Kalani. *Central Publishing House,* Jodhpur. Rs. 15.50, 1965. 514 pages.

This book deals with more advanced topics of strength of materials and theory of structures. Both the parts together, cover the entire course of engineering degree, diploma, and A.M.I.E. examinations. In this part also, the authors have included a large number of illustrative solved examples.

The book is written in metric system of units with an exception to few examples in British system of units.

6. **Network Analysis.** M. E. Van Valkenburg. *Asia Publishing House*, Bombay. 2nd edition, 1965. 492 pages.

This book is designed for use in an introductory course in electric network analysis. In this second edition, more examples have been provided and some topics have been dealt with in more depth than in the first edition. The new topics added include the two-port parameters, complex loci and Bode plots, average power, power transfer, and insertion loss. The appendices provide the coverage of complex numbers, matrices, and magnitude and frequency scaling.

7. **Elements of Workshop Technology—vol. 1.** S. K. Hajra Chowdhury and S. C. Bhattacharya. *Asia Publishing House*, Bombay, Rs. 10.50, 2nd edition, 1965. 388 pages.

This revised edition of the book aims to present the fundamental aspects of workshop procedure, and is designed to cover the complete syllabus in the subject prescribed for diploma and degree students of mechanical and electrical engineering. It is written in metric system of units.

8. **Facilities for Post-graduate Studies and Research.** S. D. Agrawal. *Jaswant Publishing House*, Ludhiana, Rs. 6.50, 1965. 130 pages.

In this book, the author has tried as far as possible to present broad-based and uptodate information regarding the post-graduate studies and research in engineering and technology in India and abroad. A selection of institutions and courses has been made to keep the volume of the book within the reasonable limits.

9. **Building and Engineering Contracts.** B. D. Virmani. *Engineering Law Publications of India*, Lucknow, Rs. 15, 1966. 204 pages.

The success of engineering operations largely depends upon the mutual understanding between the parties—the employer, contractor, engineer, and specialists. This book deals with formation, placing management and discharge of contracts. It is useful for business community in the construction industry, government engineering departments and technical institutions, and other allied organizations owing to its thorough coverage of professional practices, legal factors, and other objectives.

10. **Elements of Heat Engines.** N. C. Pandya and C. S. Shah. *Charotar Book Stall*, Anand, Rs. 17.50, 5th edition, 1966. 672 pages.

This book describes the fundamental principles underlying the subject of heat engines. It may serve as an introductory text-book for the students for the first two years of engineering degree course and those of engineering diploma course. A number of exercises and illustrative examples selected from various examining bodies have been included. The book, completely written in metric system of units, has been revised and enlarged.

PUBLICATIONS RECEIVED

A copy of the publication entitled 'Directory of Members' of Chemical Plant Manufacturers' Association has been received. The publication provides the information about the activity and efficiency of each member of the association in its part 1, and advertisements in part 2.

A copy of the 13th edition of 'Indian Engineering and Industries Register' has been received. This publication, divided into nine sections, *viz.*, index to commodities, advertisers' index, industrial houses, buyers' guide, overseas exporters, and association and institutions, will serve as a daily reference manual for buyers and sellers of engineering products.

A copy of publication no. 27, 1965 entitled 'Design of a Stanchion and Truss Frame' has been received from British Constructional Steelwork Association. This brochure contains the design of a typical single span stanchion and truss frame shed in mild steel as well as high yield steel by the 'elastic method'. The design is in accordance with B.S. 449 : 1959 and amendments up to and including Amendment no. 5 : 1965. The appendix given contains a design procedure for side rails.

A copy of the publication of British Constructional Steelwork Association entitled 'Buildings in Composite Construction' has been received. This publication contains pictorial demonstration of composite construction and shows how the method can be employed economically in erection of multistorey buildings, such as offices, flats, colleges, warehouses and car-parks.

Received a copy of the record discussions of 2nd joint meeting of Study Groups on Pile Foundations, held on January 25, 1966, at the Sir R. N. Mookerjee Hall of the Institution. The meeting was held under the joint auspices of the Central Public Works Department, Government of India, and the Institution.

OBITUARY

The sympathy of the Institution is extended to the relatives of those whose passing is recorded here.

Shri H. R. Bose

Shri Himansu Ranjan Bose, B.E., M.I.E., died on April 4, 1966.

Born on April 2, 1897, at Teotia, Dacca, Shri Bose graduated in Civil Engineering from the Calcutta University, in 1920. During 1925-30, he worked as an Assistant Engineer in Burma Railway, where he was responsible for works such as preliminary and final surveys and construction of railways, construction of a major bridge over Mokhamu, and maintenance of the railway lines, etc. In 1931-42, he was consulting engineer at Calcutta. During 1942-46, he was King's Commissioned Officer, R.I.E. During the years 1946-47, he was again consulting engineer at Calcutta. Amongst the important works completed by him since 1931 are; the construction of a hospital for Indian Steel and Wire Products at Jamshedpur, a 6-storeyed reinforced concrete building with pile and reinforced concrete foundation, and Fire Brigade Training School at Dum Dum. From 1947, he served the East Indian Railways as an Executive Engineer and conducted preliminary and detailed surveys, etc.

Shri Bose joined the Institution as Associate Member in 1930 and was transferred to Member in 1950.

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, industrial and other organizations employing engineers. It is hoped that employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

SITUATIONS WANTED

CIVIL ENGINEER, well qualified, with 22 years experience in planning, designing, organizing construction of various types of structures, residential, non-residential and industrial buildings, including R.C.C. framed structures, roads, drainage, etc., is available for engagement in any government or semi-government organizations or big private concerns. Willing to work anywhere in India preferably South India (Office ref. E.S. 230).

RADIO ENGINEER, age 37 years, M.Sc. in Applied Physics with wireless as special subject of Calcutta University. Associate Member of the Institution of Engineers (India) in Electrical Engineering with Radio Communication and Electrical Measurements as special subjects having more than 10 years of practical experience in maintenance of transmitters, broadcast receivers, audio visual equipment like projectors, tape recorders, etc. (Office ref. E.S. 231).

YOUNG ENGINEER, Graduate Member of the Institution of Engineers (India) with first class degree in Electrical Engineering, with nearly 3 years of experience in project work and erection of processing and refrigeration plants—both mechanical and electrical installations—employed in Bombay with an established organization, drawing about Rs. 800.00 p.m., seeks a suitable change preferably to a firm in Madras (Office ref. E.S. 232).

YOUNG CIVIL ENGINEER, age 27, passed B.Sc. examination of Agra University, possessing first class diploma in Civil Engineering with 72.4% marks and Sections A and B of the Associate Membership Examinations of the Institution of Engineers (India), having 5 years experience out of which 2 years in design and a years in construction Works, at present Junior Engineer, seeks suitable change in Government or in a big private organization (Office ref E.S. 233).

YOUNG ELECTRICAL ENGINEER; age 24 years; possessing first class diploma (3-year course) in Electrical Engineering with distinction in Power Group, and passed sections A and B of the A.M.I.E. examinations with Utilization of Electric Power and Electric Traction as optional subjects, and passed six papers in Section B of Mechanical Engineering Division with Air Conditioning and Refrigeration as optional subjects; having 4 years experience in Designing, Planning, Estimating, Erection and Maintenance of electrical installations in residential, commercial and workshop buildings; hard working, seeks suitable challenging position with guaranteed bright future in a leading industrial concern (Office ref. E.S. 234).

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Sub-Centres

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Dhanbad	P.O. Sindri Institute, Dhanbad.
Durgapur	C/o Deputy Chief Engineer (Civil), The Durgapur Projects Ltd P.O Durgapur-2, District Burdwan, West Bengal *(Telephone DGP-24).*
Jammu	C/o Office of the Superintending Engineer, Electric Project and Planning Circle, Jammu, Twai.
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Nagarjunanagar	P.O. Hill Colony, Vijayapuri North, Nalgonda District, Andhra Pradesh.
Neyveli	Central Technical Office, Block 1, Neyveli 1, Madras State *(Telephone 2361).*
Ranchi	C/o Electrical Executive Engineer, Ranchi Electric Supply Division, Old Secretariat Building, Doranda, P.O. Hinoo, District Ranchi.
Roorkee	C/o University of Roorkee, Roorkee.
Rourkela	C/o Department of Electrical Engineering, Regional Engineering College, Rourkela-8.

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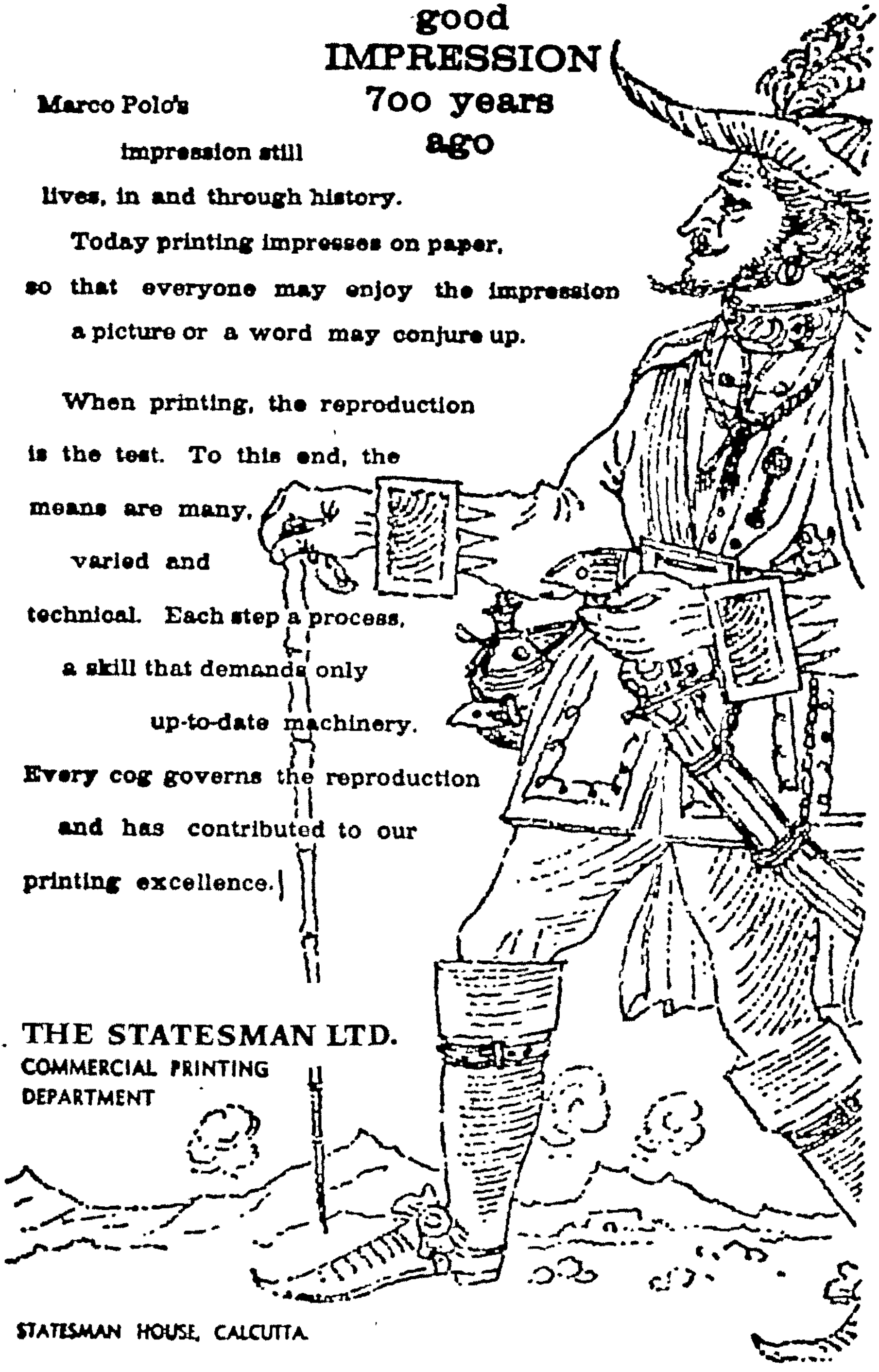

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1. **Illustrious Profiles.** Dildar Hussain, Past-President, The Institution of Engineers (India). 35 pages. Rs. 4.00.

Engineers' biographies are recent additions to literature; it is said that, 'The present generation will be found lacking in perspective if no action is initiated............to compile the biographies of the eminent engineers who have made us what we are today'.

The 'Illustrious Profiles', with the life-stories of four Past-Presidents of the Institution hailing from Uttar Pradesh, is a venture of historical consequence. 'A well-written Life is almost as rare as a well-spent one': to this book, no better epitaph can be assigned.

2. **General Sir Arthur Cotton.** Lady Hope. Reprinted by The Institution of Engineers (India). 530 pages. Rs. 20.00.

Dr. K. L. Rao, the Union Minister of Irrigation and Power, recently wrote: 'Until about a hundred years ago, India was the victim of frequent famines. But thanks to the magnificent irrigation projects executed by brilliant British engineers like Sir Arthur Cotton in the South............famine has practically vanished from the land'.

Reprinting the book, 'General Sir Arthur Cotton', the Institution has rightly paid homage to a great engineer whose genius and dedicated service stood between famine and prosperity. Presented in a pleasing format, the book is an invaluable possession to any engineer.

3. **Use of Fly Ash in Building Industry.** The Institution of Engineers (India). 18 pages. Rs. 2.50.

The contents of this monograph highlighting the features of the versatile building material, fly ash—an industrial waste produced in profusion in the thermal stations of our country and difficult of disposal as produced—comprise observations of a research team at the Central Building Research Institute, Roorkee.

4. **Proceedings of the Seminar on 'Technical Education and its Development (1966-81)'.** The Institution of Engineers (India). 477 pages. Rs. 20.00.

A heart-searching enquiry proceeds now in respect of engineering education. The queries are many and varied: 'Education in this country has lost its way', 'The story of engineering education is a story of unexamined assumption', 'Engineering Education is no longer a matter to be left entirely to the professional educationists', etc.

What do we expect engineering education to achieve? In this *Proceedings*, the Institution records the views expressed by Engineers from all corners of the country. It also embodies the Recommendations presented by the Institution to the recently appointed Education Commission.

(Continued on page 7)

Scheme of Institution Publications

Publication	Symbol	Frequency per year	Month of publication											
			January	February	March	April	May	June	July	August	*September	October	November	December
Bulletin	*BU*	12	BU5	BU6	BU7	BU8	BU9	BU10	BU11	BU12	BU1	BU2	BU3	BU4
Civil Engineering Division Part	*CI*	6	CI3		CI4		CI5		CI6		CI1		CI2	
Mechanical Engineering Division Part	*ME*	6	ME3		ME4		ME5		ME6		ME1		ME2	
Electrical Engineering Division Part	*EL*	6		EL3		EL4		EL5		EL6		EL1		EL2
Electronics & Tele-communication Engineering Division Part	*ET*	3	ET2				ET3				ET1			
Chemical Engineering Division Part	*CH*	3		CH2				CH3				CH1		
Mining and Metallurgy Division Part	*MM*	3			MM2				MM3				MM1	
Public Health Engineering Division Part	*PH*	3		PH2				PH3				PH1		
General Engineering Part	*GE*	3	GE2				GE3				GE1			
Hindi Section	*HI*	3				HI2				HI3				HI1

* A new volume commences in September each year and ends in August next year.

RULES FOR SUBMISSION OF PAPERS FOR THE *JOURNAL*

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2. Three manuscript copies, accompanied by one set of original Indian ink drawings and two sets of blueprints (one attached to the second copy) and another to the third copy of the manuscript) and at least two sets of glossy photographs, if any, should be submitted, with the author/s retaining copies for his/their own file. The author/s should give his/their name/s in full, grade of membership and membership number, designation, and present address. Any change of address at a subsequent date should also be promptly informed.

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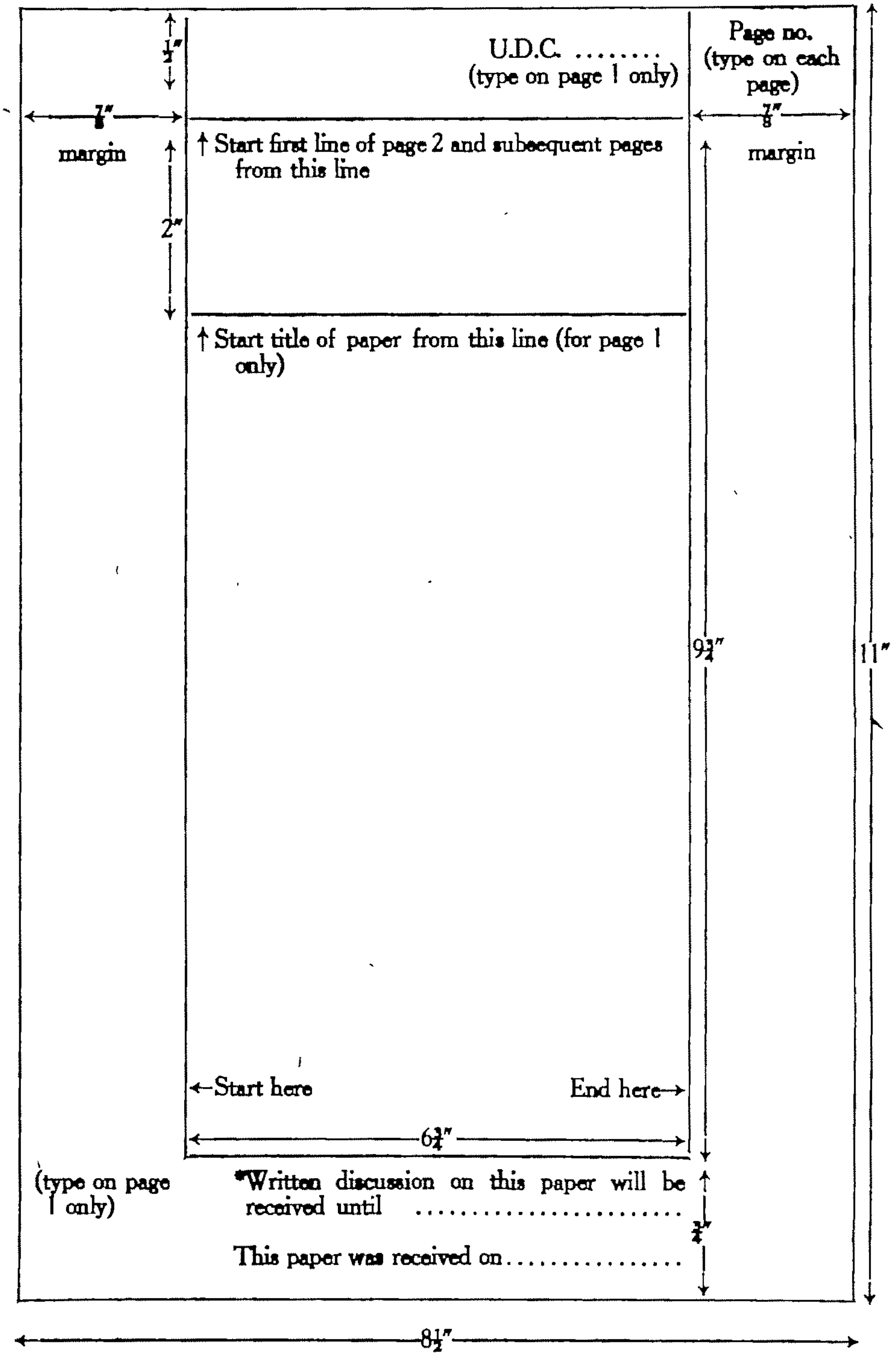

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PUBLICATIONS FOR SALE

(Continued from page 1)

5. **Proceedings of the Symposium on 'Economy and Efficiency of Engineering Enterprises in India'.** The Institution of Engineers (India). 242 pages. Rs. 15.00.

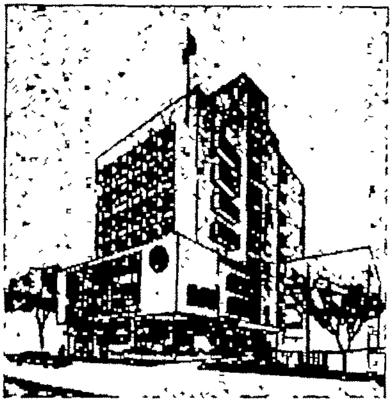
In an age dedicated to productivity, the need for economy and efficiency in Indian enterprises is well understood. Nevertheless, obstacles abound on the way. In this *Proceedings*, 'The problem has been stated, the maladies described; and the solution suggested—unanimously by the engineers in the country'.

6. **Proceedings of the Symposium on 'Prestressed Concrete'.** The Institution of Engineers (India). 265 pages. Rs. 15.00.

In this *Proceedings*, the papers presented in the Symposium held on February 21, 1955, at Hyderabad, under the joint auspices of the Institution and the Concrete Association of India, have been compiled.

7. **Proceedings of the Symposium on 'Prestressed Concrete'.** The Institution of Engineers (India). 226 pages. Rs. 15.00.

In this *Proceedings*, the papers presented in the Symposium held by the Institution on February 4-7, 1960, at New Delhi, have been compiled.



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APPEAL OF SHRI K. K. NAMBIAR *(M.)*, CHAIRMAN, CIVIL ENGINEERING DIVISION

It is often stated that today we are in the midst of a second Industrial Revolution brought about by recent scientific discoveries. While in the first revolution man succeeded in harnessing mechanical forces, the second revolution has introduced electronic devices which are capable of supervising the operation of machines and has thereby extended the realm of the human brain. Thus, while the symbol of the economic revolution of the seventeenth century is the loom or the steam engine, the symbol of the present revolution is the electronic brain.

But while the first revolution, with concomitant improvements in agriculture and transport, made food amply sufficient to foster population growth, the wake of its successor has put civilisation on a bitter race with famine, the outcome of which is still in doubt. This second revolution is also marked by a 'revolution of rising expectations' amidst two-thirds of mankind, who make their living as 'peasant farmers'.

Besides this, there remains the haunting possibility of a 'population explosion'. The population, which doubled in the century ending in 1920, looks like doubling again in the 50 years from 1920 to the end of this decade and, if further extrapolation of the curve is permissible, the population of the world by the year 2000 is likely to be about 6,000 million.

Lord Boyd Orr, in his book 'Food and the Future', stated that: '....If known measures were taken to increase the area of earth under cultivation. . . . . . , the earth could support a population of 6,000 million'. While the spirit of science and technology refuses to accept such a forecast of the 'Doomsday', the challenge to the statesmen, scientists, technologists and the farmers is no less exacting.

Agriculture has so far been regarded as a 'way of life' of two-thirds of the world's population. It is now agreed that for the survival of our civilisation, agriculture has to be organised as an 'industry', run by the combined effort of the statesmen, scientists, engineers and technologists with the 'peasant farmer' as the nucleus.

India's efforts to overcome her food deficiency has also followed the same course of action. The fruits of applied chemistry such as selective weed killers, insecticides, plant hormones, etc., are being introduced in farms: the production and utilization of chemical fertilisers are given the highest priority in the Plans; better implements and machines are put in agriculture; and various multi-purpose projects have been completed to supply water in the networks of irrigation channels.

The outcome has not been enough; nor the rate of growth ample to cope up with the eventualities facing us in the years ahead. The intensive exertion on 'agriculture' and 'land use' must bring in more of land reclamation projects, land and soil conservation schemes, maintenance of old irrigation works and canals, sinking of more tube-wells, improvement of filled up tanks, etc. No less important is the design and construction of improved types of silos utilising the advanced knowledge in structural engineering.

Research in the areas of storm runoff and erosion, management of the forest and pasture lands, soil-conservation farming, upstream control of 'little waters', desalting of brackish and saline waters, erection of underground basins of shattered rock in the earth's crust by atomic explosions for storage of excess flood waters, etc. are engaging the attention of scientists and engineers the world over.

The problems in the management of watersheds are directly related to the dynamics and disposition of the rain-drop. The land, which lies between the point where a raindrop strikes the earth and the river, is moulded surprisingly by the chemical and mechanical actions of the raindrops. It has been estimated that the total impact of a storm's raindrops in an hour may splash around about 250 tons of soil per hectare of cultivated land. It has also been determined in the U.S.A. that the seven inches of topsoil in bare ground would be completely eroded away in 15 to 20 years whereas it would take 96,000 years to erode away seven inches of topsoil under a good grass cover or under a closed forest cover.

Hydrological studies are also of great importance. The studies of underground water flow has been greatly helped by the use of radioactive Titrium. It is now known that while the river bed dries up on the surface, considerable amount of water flows to the sea through the underground strata, which can be stored and utilised for agricultural purposes by constructing 'underground dams'.

In this battle for survival, the 'civil engineer' occupies an ominous place, in that, hand in hand with the scientist, he takes part in the areas of activity mentioned above. In our country, too, the civil engineers have been actively engaged in this national enterprise. Nevertheless, the need for 'ideas' and 'efforts' has never been felt so strongly as at the present moment. Dr. K. L. Rao, the Union Minister of Irrigation and Power, has recently urged that: 'Without new ideas, beneficial engineering will freeze. Progressive research is the key to further the advance of civilisation'.

The Institution of Engineers (India) has continued to serve in the fostering and dissemination of the advanced knowledge gained in technology. Keeping pace with tradition, the Chairman of the Civil Engineering Division Board of the Institution, invites papers on the theme of engineering directed to 'Maximisation of Food Production' in the country, for publication in the Civil Engineering Division Part of the Journal.

DEVELOPMENT OF COMPUTER LANGUAGE FOR CIVIL ENGINEERING *

Introduction

On December 10, 1964, C. L. Miller, Professor of Civil Engineering, Massachussets Institute of Technology, U.S.A., sat down before a typewriter-like IBM data terminal in Atlanta, Georgia, and dialed the long distance telephone number of an IBM 7094 computer back at his home institution in Cambridge, Massachusetts Institute of Technology.

Once the connection was made, he proceeded to use the problem-solving capabilities of the large scale 7094 to design a highway interchange. And he did this despite the fact that engineers at some 30 other terminals scattered around the MIT campus were using the same computer.

Now, designing a highway interchange on a computer that is more than 1,000 miles away and that 30 other people are using at the same time is an excellent example of the advanced state of the computer art. And it was especially interesting to the professor's onlookers, all delegates to the Atlanta meeting of the American Association of State Highway Officials.

But every bit as important, in an unobtrusive way, is the medium by which Professor Miller was able to accomplish his feat—a computer language so easy to learn and use that any engineer there, with a few minutes instruction, could have done precisely the same thing.

In the world of computers and the world of civil engineering Charlie Miller is known as a man who played an important role in the introduction of the former to the latter. Especially, he is known as the creator of COGO, short for COordinate GeOmetry, the simple programming language that enables the civil engineer to use the computer literally on his own terms, using many of the same civil engineering words he has always used.

Programming eased

'What the advent of COGO meant,' said Professor Joseph Pistrang recently, 'was that the civil engineer no longer had to employ a programmer or go to programming school to learn to translate his problems into a special language to use the computer. Insteatd, with just a handful of commands —and these drawn from the language of his own profession—he could do virtually any geometry problem that might come up, and do it faster. It made the computer as easy to learn to use as the slide rule.'

Unlike basic machine language which requires strings of numbers, or a higher level language like FORTRAN (FORmula TRANslation) which handles problems after they have been translated into algebra, COGO more closely resembles the English language. And it's made up entirely of a vocabulary of terms common to the civil engineering profession, such as: azimuth, tangent, angle, distance, area, arc, girder, deflection, and so forth.

Under such a scheme the engineer need not give all instructions in a step-by-step fashion. He just gives the machine what is known, then commands it to come up with what he wants to know. If, to cite a very simple example, he stores the coordinates of points 1 and 2 in the computer and wants to know the distance between them, he merely gives the command

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* Contributed by IBM World Trade Corporation, U.S.A.

'DISTANCE 1 2' to the computer and it responds, typing the distance between 1 and 2. If he wants to know the area within points 1, 2 and 3, he asks the computer, 'AREA 1 2 3 1' and it answers. The same principle applies for geometric problems of varied complexity.

It is easy to understand, then, why COGO has found increasing acceptance and popularity among civil engineers, especially those working in such heavily geometric fields as highway, bridge and railway design, land subdivision planning, surveying and right-of-way. It is easy to understand how COGO has helped stimulate the development of various new versions of itself as well as other similar languages, tailored to the words and needs of other engineering disciplines. But computer people are still somewhat surprised by some of the places where COGO appears. One glass-blowing firm has adapted it to its geometric-shape problems. They nick-named it BLOWGO.

As is often the way with really significant innovations, COGO came into the world rather obliquely. ('We backed into it,' recalls Professor Miller.) And once developed, in the Puerto Rico Department of Public Works at San Juan, it was perfected by Professor Miller during the early 1960s when he was shuttling between there and his home base in Cambridge.

Beginnings in 1959

Professor Miller, who already had something of a reputation in computer-aided civil engineering, was retained by Puerto Rico's Highway Director Angel Silva in 1959 to set up a computer operation in his department—and train his engineers to use it.

In a matter of days after Professor Miller started working with the Puerto Rican group he had a few programmes in operation on road-building problems. Then, through most of 1960—rather than lecturing to the engineers—he concentrated on building up a library of programmes, using the algebra-based FORTRAN language. Working directly with the men, he used the computer to help solve their problems. Still, Professor Miller was not satisfied with his progress.

In late 1960, 'Without quite knowing why,' Professor Miller says, 'he decided to get away from computing for a while, and went back to the drafting board as an engineer in the Puerto Rico highway department's urban design section.' It was, he recalls now, a revealing experience. 'I discovered that we had been so preoccupied with writing programmes that we had lost perspective. We were writing programmes, then looking for real-world problems to fit them—a sort of matching process. What suddenly became clear to me was that we should be devising solutions to the problems. But this is impossible with traditional programmes: in highway engineering there is an infinite number of geometric problems and each can be a shade different from all the rest. Certainly one could not have a programme for each problem. But when you examine it more closely you find that the number of different operations performed in solving the problems is limited, and it is the order or sequence of operations that is infinite.'

New approach

This moment of truth, so to speak, was the recognition of the real problem, rather than its solution. (The only thing Professor Miller decided with certainty then was that 'every programmer should go back to the drawing board at least once a year to keep his focus on applications rather than on programmes.') So Professor Miller went to work on a system that would recognize (1) the civil engineering design process and problems, and (2) the different operations used in arriving at solutions.

By mid-1961 the original version of COGO, civil engineering's 'problem-oriented' language, was complete—partly accomplished in Cambridge, partly in Puerto Rico. It had 10 commands, and instead of using coded numbers for these commands, as used in the first experimental version, Professor Miller used words right from the engineer's own working vocabulary—to help break down the psychological barrier between man and machine. Within a month the number of commands had doubled; in two months there were 40; then Professor Miller put the ceiling at 50, to keep it from getting out of hand, from getting so complex it defeated its own purpose.

His Puerto Rican COGO system behind him, Professor Miller set about putting together a U.S. version to take into consideration the differences in engineering practices. About that time, November 1961, he was named —at the age of 32—the head of MIT's civil engineering department. His reputation, and COGO's, continued to grow. And in order to assure COGO's proper maintenance and orderly availability to the entire civil engineering profession, Professor Miller turned it over to IBM.

Catalytic action

When asked for his own appraisal of COGO he says:

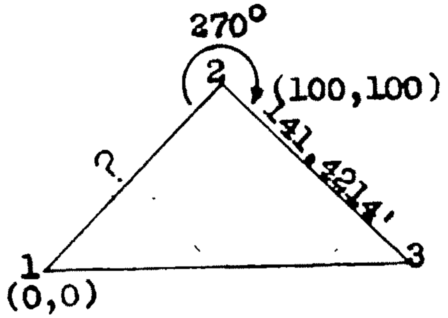
'Its real significance is not so much in what it does, but the extent to which it has been a source of ideas, a test model. The results go beyond the solution of certain engineering problems, important as that goal is. The results have proved a catalytic stimulus toward progress and have stimulated others even where there was disagreement about approach.'

For his own purposes Professor Miller finds COGO most valuable in helping him to use the computer in the classroom—also a field he has pioneered. 'When the computer is accessible through a high-level language, the professor and the students can do effective problem work within the time frame of the classroom,' he says.

In true milestone fashion, COGO has proved to be a beginning rather than an end, the start of something substantially bigger than itself. From Professor Miller's group at MIT and elsewhere have come versions of COGO adapted to computers other than the IBM 1620 for which it was originally designed. Paralleling these extensions of COGO has been the development of problem-oriented languages for other areas of civil engineering—STRESS, the STRuctural Engineering System Solver, SEPOL, the Soil Engineering Problem-Oriented Language, POGO, an extension that adds profile geometry to COGO.

Now Professor Miller and his colleagues are developing a broader approach to the use of computers by all segments of the civil engineering profession. Called ICES, for Integrated Civil Engineering System, its objective is to enable the civil engineer to satisfy within a single framework all his computational needs. This concept is being implemented on MIT's IBM System/360.

Tackling a simple problem with COGO



Here is how an engineer would solve a simple problem with COGO Assume that he wanted to compute exact boundaries and the area for a triangular piece of land, as shown on the above diagram:

First, he puts into the computer a deck of punched cards containing the COGO programme.	
He knows coordinates of point 1, thus he types into the computer ...	STORE 1 0.000 0.000
which means store in the computer the coordinates (0.000 North, 0.000 East) for position 1.	
He also knows coordinates of point 2, thus types into the computer ...	STORE 2 100.000 100.000
He wants to know the distance between points 1 and 2, thus he types	DISTANCE 1 2
The computer responds	1 2 141.4214
which are the point numbers and the distance between them in feet.	
The engineer—who knows the angle 1, 2, 3 (270°0′4″) and distance between 2 and 3 (141.4214 ft.)—now wants to find coordinates for point 3. He types in	LOCATE/ANGLE 1 2 3 270 0 0. 141.4214
which asks for the position of 3 while giving the machine the angle 1 2 3 and the distance between 2 and 3.	
The computer responds	0.000 200.000
which is the position of 3.	
The engineer then asks for the area with the command	AREA 1 2 3 1
The computer responds	10000. .22956841
which of course is the area in sq. ft. and acres.	

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THE MULTI-PURPOSE RESEARCH REACTOR AT KARLSRUHE *

Introduction

The Multi-purpose Research Reactor (MZFR) is a combined power and test reactor with a thermal output of 200 MW. The reactor has been developed by Siemens-Schuckertwerke AG and is of the natural-uranium type with D_2O as coolant and moderator. It has been put into operation in the Nuclear Research Centre at Karlsruhe on the Rhine early this year. The decision to construct the MZFR was made in 1961 by the German Federal Ministry of Atomic Energy in order to give the German reactor industry the opportunity of gaining experience in the design, construction and operation of reactors of a progressive type.

Overall arrangement of the plant

The multi-purpose research reactor has a double function : power generation and testing.

The power station is designed for a net output of 50 MW measured at the primary terminals of the generator transformer. As the prototype of the natural-uranium D_2O line, its main purpose is to provide operating experience and help pave the way for the economical operation of larger reactors of this type. As a test reactor, it represents a high-capacity device for the testing of further-developed fuel elements under operating conditions and for irradiation investigations. The high neutron flux density of 10^{14}n. per cm.^{2} is of considerable importance for tasks of this nature.

The schematic diagram of the plant is shown in Fig. 1. In the development and design of the various parts of the plant, special attention has been paid to safety and to the drawing of a clear dividing line between the reactor plant and steam power plant, in addition, of course, to the normal points which require consideration in the construction of a power station.

Reactor plant

A sectional view of the model of the nuclear power plant building is shown in Fig. 2. The reactor is operated with natural uranium as fuel and D_2O as coolant and moderator. The reactor plant consists mainly of the pressure-vessel reactor, two parallel-connected main coolant circuits, a moderator circuit and various ancillaries. The heat generated in the reactor is passed to the steam and feedwater circuit of the steam plant *via* the two steam generators and the moderator coolers.

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* By courtesy of Siemens-Schuckertwerke AG, Erlangen, Germany.

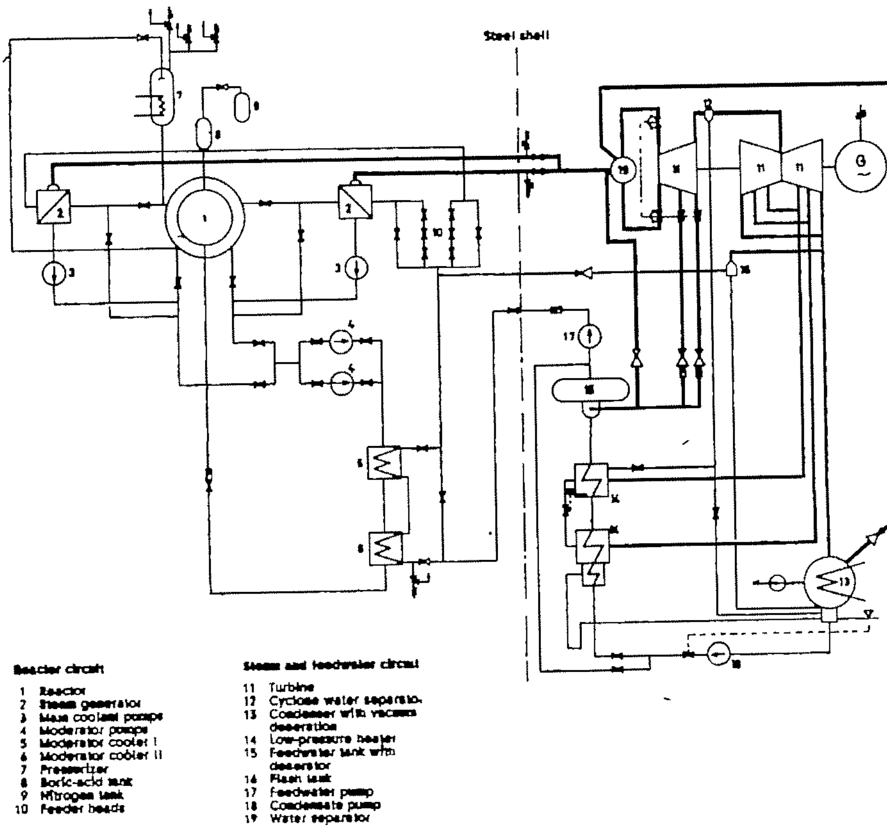

Fig. 1

Schematic diagram of the multi-purpose research reactor plant at Karlsruhe

The reactor vessel has a diameter of 4,100 m. (13 ft. 5 in.) and a height of 7,845 m. (25 ft. 9 ins.) and is designed for a pressure of 100 kg. per cm.^{2} abs. (1,422 lb. per sq. in absolute) at 300°C. This contains the moderator vessel, which, together with the throughgoing separating tubes, serves to separate the moderator from the coolant. The complete reactor core consists of 115 fuel element stacks with a total natural-uranium dioxide (U_2O) weight of 13.5 tonnes.

Each stack consists of two axially coupled fuel elements, each of which comprises 37 concentrically arranged fuel rods. The fuel-element cans consist of 0.6 mm. thick Zircaloy tubes which are loaded with sintered UO_2 pellets, filled with an inert gas welded gastight at the ends. A new type of charging machine (designed by Siemens-Schuckertwerke) permits reshuffling and replacement of the fuel elements during operation. Arranged inside the cylindrical reactor pressure vessel is the moderator tank which keeps the cold moderator separate from the hot coolant. Some 121 vertical separating tubes arranged in a hexagonal lattice pass through the moderator tank, 115 of these containing fuel elements and the remaining 6 serving for experimental purposes. The reactor is equipped with one control rod and 16 shut-down rods which are arranged in groups of three on the periphery of the reactor vessel. It is possible to limit the number of control rods to one because the reactivity can be changed by varying the mean moderator temperature. The other 16 rods serve for quick shutdown. Fig. 3 shows the head of the reactor power vessel.

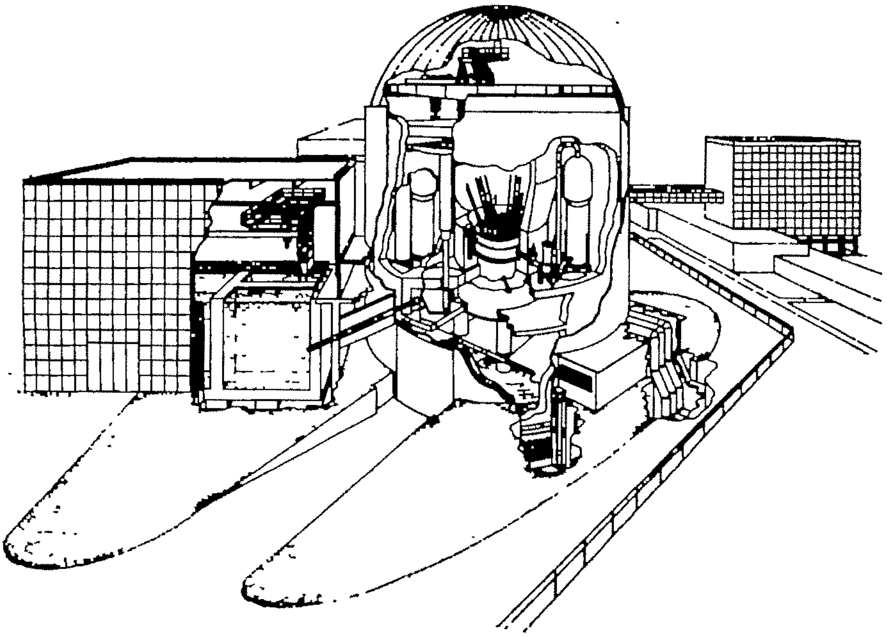

Fig. 2

Sectional view of the model of reactor building and store for spent fuel elements

The two main cooling circuits each consist of a steam generator, a main coolant pump and the connecting pipes. On its way through the cooling channels the D_2O—this is pressurized to 90 kg. per cm.^{2} abs. (1,280 lb. per sq. in absolute)—is heated from 251.5 to 280°C. The total throughout is 4,650 tonnes per hr. From the upper collector of the reactor vessel the D_2O flows into the two steam generators in which the heat absorbed in the reactor is used to generate saturated steam. During this process the temperature of the D_2O flows into the two steam generators in which the heat absorbed in the reactor is used to generate saturated steam. During this process the temperature of the D_2O is reduced to 254°C. The two main coolant pumps, which are equipped with a canned rotor motor to prevent leakage, return the D_2O to the reactor.

Parallel to the main cooling circuits is a moderator circuit consisting of the two moderator coolers and a moderator pump. The heat drawn from the D_2O in the moderator coolers is used for final preheating of the secondary side feedwater. The feedwater supply system is designed to allow the moderator inlet temperature to be varied steplessly between 80 and 200°C.

In this manner it is possible to regulate the reactivity of the reactor without taking any action on the primary side.

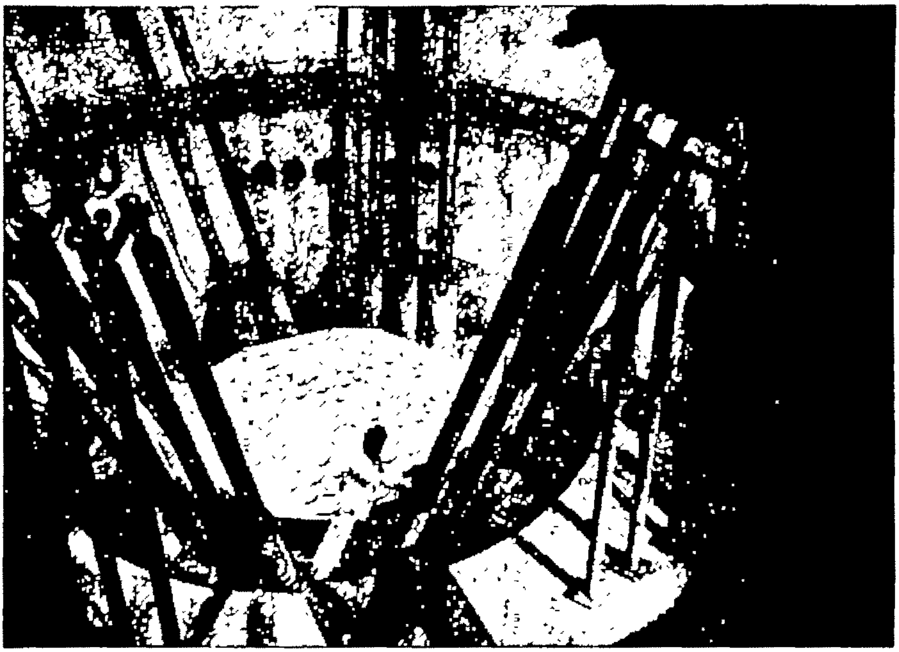

Fig. 3

View of the head of the reactor pressure vessel

In addition to the main circuits, the reactor plant includes various auxiliary and ancillary systems. To main the required pressure in the primary circuit and to correct pressure fluctuations due to temperature changes, a pressurizer vessel with built-in electric heating and a spray system is connected to the main circuits. The pressurizer vessel is partly filled with heavy water and D_2O vapour. Whether the heating or the spray system is made operative depends on the volume change. Also connected in the parallel circuit is a D_2O purifying circuit for the removal of corrosion products, fission products and boric acid. A D_2 gas system, which can likewise be switched in, serves to collect all D_2O and D_2 gases or gases containing fission gases from the various parts of the reactor plant. They are then treated and passed to the waste store or to the exhaust gas chimney.

The piping for the primary circuit is of the seamlessly rolled full-wall type manufactured from Nb-stabilized 18/8-Cr-Ni steel.

The plant is provided with a charging machine equipped with a remote-controlled co-ordinate trolley which permits the reshuffling or replacement of every fuel stack during operation. By means of a transfer machine it is also possible to interchange the elements of a stack and to reinsert them in the cooling channel via the charging machine. Hence, it is not necessary to interrupt operation for recharging and the head of the reactor vessel can remain closed. This arrangement also affords three more advantages: the burnup can be almost doubled, the fuel elements are burned up equally over the entire length and the power density distribution in the reactor can be kept practically constant independent of the burn-up.

Steam power plant

On the secondary side, the two steam generators produce saturated steam at a pressure of approx. 33 kg. per cm.' abs. (470 lb. per sq. in. absolute). The live steam output of 498 tonnes per hr. is used to drive a turbo-set designed for an output of 57 MWe. The turbine consists of a high-pressure part and a double-flow low-pressure part. Since saturated steam is used for this plant it was necessary to install a mechanical cyclone water separator in the crossover pipe between the high-pressure and lower-pressure part to reduce the moisture content of the steam in the final stages of the low-pressure part. The steam flowing from the exhaust connections of the turbine is passed to 2 oval condensers. A condensate pump conveys the condensate through the feed heating plant and the direct-contact deaerator heater to the 100 m'. (3,530 cu. ft.) feedwater tank. The feedwater, raised to a temperature of 111°C, is now forced by a main feedwater pump through the moderator coolers to the steam generators. Parallel to the feed heaters is a bypass-line for regulation of the moderator temperature. Worthy of mention in this connection is an additional vacuum deaerator which ensures that the oxygen content of the feedwater is kept to a minimum, in accordance with the stringent requirements, when the main deaerator is bypassed. To cover the contingency of cooling water entering the main condensate pipe, a demineraling plant designed for the full quantity of condensate is incorporated.

Since no river water is available within a reasonable distance two cooling tower units each with 8 cells have been erected in the north-west corner of the power-station grounds. These supply the condensing plant and other cooling points in the power-station with cooling water (total cooling water requirement being 18,000 m'. per hr. of 635,000 cu. ft. per hr.

Electrical plant

The energy for the auxiliary requirements is tapped direct from the main generator leads and fed to the 6 kV system through a 12.5-MVA transformer. When the turbo set is shut-down, the power-station is started up via the unit auxiliary transformer. After the turbo-set has been synchronized, power is fed into a 110 kV system via the step-up transformer and the outdoor switching station. A standby transformer, the high-voltage side of which is coupled to a 20 kV distributing station, is provided to cover the possibility of faults occurring in the step-up transformer or unit auxiliary transformer or in the associated bus connections. The station service loads are connected to a 6 kV system with sectionalized single busbars. The large electric motor drives with ratings above 150 kW are connected direct to both 6 kV sections. The low-voltage loads are likewise connected to both sections but via transformers. Motors with the same function are distributed evenly over both sections to permit limited operation of the plant in the event of one section failing. Essential three-phase loads are fed by a 380-V fail-safe system. This consists of four motor-generator sets with flywheels and stand-by diesel engines. In normal operation the motor-generator sets are fed from the 6-kV service system. In the event of a fault in this system the diesel engines are started by the energy stored in the fly-wheel and can supply full output within 2 sec.

Experimental equipment

In addition to supplying power, the multi-purpose research reactor can be used for testing fuel elements, reactor materials and coolants. Six specially equipped channels in the centre area of the core make it possible to carry out experiments on fuel elements with coolant, pressure and temperature conditions which are independent of the reactor circuit. Additionally, one of the inclined positions, such as are provided for the control rods, is designed to accommodate radiation samples by the insertion of a pressure-tight thimble. The samples are accommodated in standard capsules about 200 mm. (8 in.) long and are inserted one after the other. This channel extends into the range of maximum neutron flux density of more than 10^{14} n.per cm.^{2} s. The extension of the radiation tube projects into the reactor chamber from where the capsules are placed in a transport container by means of a special device and transported to the hot cells.

The experimental devices are designed to permit the following:

Standard checking of power reactor fuel elements under normal operating conditions; circuit experiments in the reactor with various coolants; irradiation experiments on reactor materials; production of radio-active isotopes, and so on.

Safety

Quite apart from external safety measures, the reactor is designed to give the maximum possible inherent safety. All temperature and power coefficients are negative. Furthermore, the temperature coefficient of the coolant is kept small to prevent faults in the steam power plant from having a serious effect on the reactor. At the commencement of boiling the void coefficient is also negative and cannot become positive until boiling conditions obtain, which are practically an impossibility. While the measures for controlling the reactor power can be considered absolutely safe, the possibility of coolant loss could not be fully precluded and requires additional external safety measures.

Th individual components of the plant are designed to provide for full control of all operating conditions and extraordinary faults without there being any danger of persons inside or outside the plant being exposed to impermissible radiation doses. The very principle itself of the pressure-vessel reactor with its closed circuit provides an important advantage from the standpoint of safety. For instance, all parts of the plant which may contain fission products or radio-active substances are accommodated in a separate building which is surrounded by a pressure-proof steel shell.

This steel shell is designed to contain all radio-active substances and gases escaping due to leakage in normal operation and in the case of the maximum credible accident to withstand the pressure increase resulting from released thermal energy.

To increase the safety of the plant, particularly the internal safety, the so-called pressure-suppression method is employed in which the expanding steam-water mixure from the damaged chamber is passed to a condensing tank. In this manner the pressure within the steel shell is kept to below 0.8 kg. per cm.^{3} gauge (11 lb. per sq. in.) and the temperature limited to approximately 60°C.

The closed circuits for the steam, feedwater and cooling water systems, provide further barriers against contamination of the surrounding atmosphere. All systems which may be exposed to radio-activity are supervised constantly by radiation measuring devices. Fig. 4 shows the full view of the MZFR nuclear power plant at Karlsruhe.

Fig. 4

View of the entire complex

Technical data of the multipurpose research reactor

Some salient details of thè reactor are given below:

Thermal power reactor	200 MW
Net electrical power, measured at the primary terminals of the generator transformer .	50 MW
Fuel	UO_2 natural uranium
Weight of uranium ...	13.5 tonnes
Number of cooling channels	121

Number of these for experimental purposes	6
Irradiation channel	1
Power density	14.8 kW per Kg. U
Number of main cooling circuits	2
Separate moderator circuit	1
Operating pressure of the reactor cooling system	90 kg. per cm., abs. (1,280 lb. per sq. in. absolute)
Coolant temperature at the inlet and outlet of the reactor pressure vessel	254 to 280°C.
Total coolant throughput	4,650 tonnes per hr.
Live steam pressure	33 kg. per cm^2. absolute (470 lb. per sq. in. absolute)
Live steam temperature	238°C
Live steam throughput	308 tonnes per hr.
Cooling water temperature	21°C.
Cooling water throughput in the condenser	17,200 m^3. per hr. (607,400 cu.ft. per hr.)
Apparent power of the three-phase synchronous generator	71,700 kVA at power factor, 0.8
Rated voltage	10,500 V 5%
Hydrogen cooling of the generator	2 kg. per cm^2. gauge (28 lb. sq. in.)

ADDRESSES OF CHAIRMEN AT THE ANNUAL GENERAL MEETINGS OF THE LOCAL CENTRES

Assam Centre

Chairman's address by Shri M. R. Sitaram, M.I.E., at the 7th Annual General Meeting of the Centre on February 27, 1966

After welcoming the Chief Guest, and other invitees, Shri Sitaram thanked the Committee of the Centre for electing him the Chairman for the ensuing year.

Delivering the Chairman's address, Shri Sitaram said, 'In 1947, we had practically no hydro-electric power in our State except the small station feeding Shillong which was one of the earliest hydro-electric projects in the country. Seventeen private companies, most of them having Diesel generation aggregating to 2,283 kW, were supplying electricity to a few towns, thus giving electric lights to less than .06% of the total population. The projects to be included in the Fourth Plan, *viz.*, the installation of 30,000 kW-thermal station extension of Namrup station by addition of some more gas turbines and steam turbines, and the

Umling hydro-electric project near Shillong, etc., are under examination. The total installed capacity by the end of the Fourth Plan will be 3,40,000 kW.

During the Fourth Plan, emphasis will be laid on extending the lines to the remote corners of the State. A 300 miles long, 220 kV line to interconnect the Umiam-Umtru system and the Namrup system will also be built. Agreements have been entered into for supplying power from Assam to Tripura, NEFA, and Nagaland; and negotiations are under way to supply power to Manipur and the Coochbihar area of West Bengal. It is, therefore, expected that power will be available in all the remote parts of the North-eastern zone by the end of the Fourth Plan.

The number of villages so far electrified totals to 43,000, approximately out of 5.7 lakhs of the total number of villages in the State. Realizing that the use of electricity through small scale industry and improved irrigation facilities are the only ways of bringing up the prosperity of the village population, a resolution was adopted in the Seminar on Irrigation and Power, held at Trivandrum in 1964 that one lakh of villages should be electrified in the country by 1969 to synchronize with the 100th birth anniversary of Mahatma Gandhi. It was also resolved that the minimum number of villages to be electrified in each state was to be not less than at least 20% of the villages in that State. While in Madras 46.9% of villages are electrified, we have so far electrified only 0.24% of the villages. Thus, the maximum attention has to be given to this problem of rural electrification in Assam.

After the recent crisis in food supply position in the country, the rural electrification has been given an agricultural bias and supply of power to agricultural pumps has been given maximum priority. There is great scope of such irrigation in Assam also where pumped water can be used to grow winter crops.

One of the major handicaps that was against the rapid industrialization of Assam, *viz.*, the transport and communication, has practically been overcome with the extension of the broad gauge line into Assam. In the past 6 or 7 years about 60-70 crores of rupees have been spent in improving communications in Assam. It is sometime stated that industries cannot come up in Assam because of its geographical position near international borders. But, if Europe, Germany, Switzerland, Milano (Italy), etc., could become highly industrialized, there is no reason why the geographical position of Assam should be a bar to the industrialization of the State. In fact, there are industries which should only be located in such strategic areas. In all advanced countries, energy supplies have been very powerful factors in determining the location of industries.

Regarding the trained manpower, much headway has been made in the State by opening the engineering and technological institutions in recent years, and extending facilities for training in various industries of the State. The Institution is also giving a very great prominence to this problem of trained manpower and in fact, at the 45th Annual Convention, a Seminar on 'Technical Education and its Development' was held at which various aspects of training from the artisan level to the researchers' levels were discussed and definite conclusions were arrived at. It is, therefore, expected that within a short time there will be no dearth of trained men in the State.

In Assam, much has been said regarding the problems posed by the Brahmaputra river in the form of floods, damages and destruction. It is a point for consideration by the engineers of this august body, if an autonomous organization like the Tennessee Valley Authority (T.V.A.) in the U.S.A. should not be set up for solving these problems. If multipurpose schemes similar to those sponsored by the T.V.A. are investigated and implemented, the Brahmaputra river will be a boon to Assam.

An engineer has to play a great part in building up of the country. I am sure the engineers associated with the Assam Centre of The Institution of Engineers (India) will play an important role in future for the prosperity of the State.'

Orissa Centre

Chairman's address by Shri S. Padhi, B.Sc. (Eng.), M.I.E., at the 7th Annual General Meeting of the Centre on March 12, 1966

After welcoming the Chief Guest, and other invitees, Shri Padhi thanked the Committee of the Centre for electing him once again the Chairman for the second year.

Delivering his address, Shri Padhi said, 'I propose to speak on the theme of 'Industries and Industrial Development.

The financial assistance that the industries received from banks and Government and other financing agencies by 1948 was negligible. Now, the figure is approximately Rs. 300 crores, exclusive of World Bank's loans and loans from international agencies. These amount to 6,000 million rupees. As compared to that for the entire country, the amount for Orissa is 4%, the highest being Punjab *i.e.* 17%.

There were no industries at all when our State was formed in 1936. The total power generated was primarily in the towns of Cuttack and Berhampur, and it was mostly utilized for lighting. Even the rice and oil mills in the towns were having their own Diesel power. Up to 1948, when Orissa territorially expanded with the merger of States, nothing spectacular took place except that some private enterprise set up a paper mill at Brajrajnagar in Sambalpur, a textile mill at Chowdwar in Cuttack and a sugar factory at Rayagada in Koraput. Electric supply was developed in a few more towns such as in Puri, Balasore, Jharsuguda and Sambalpur, but very little of it gave any stimulus for promoting industry in general. One hundred factories, mostly rice mills, in the districts of Balasore, Ganjam and Koraput; a few *bidi* factories and a few saw mills, here and there, were all that could be called 'industry' by 1945 in Orissa.

Orissa is a State of 1,76,000 sq.km. area with a population of 17.5 millions. Of this population, 20% are tribal ; and excluding the coastal areas, they are the inhabitants of the hilly regions. The main employment of our people is agriculture which is seasonal only. But compared to other States with backward agricultural economy, unemployment has not manifested prominently here. Also, in terms of labour productivity, our State is a poor performer. On an average, our people are, underfed, poor and suffer from the ravages of disease, flood and famine.

Japan, which is only about double the size of Orissa in area, has been able to develop itself to an extent which enjoys respect from small countries. In contrast, Japan has hardly any mineral wealth, and is susceptible to various calamities of nature like earthquakes and typhoons; and inspite of its being ravaged by the last war, it is the third biggest producer of steel in the world. In 1964, she produced 40 million tons of blister steel and exported 7 million tons of steel products. In the year 1964 alone, an aggregate of 4 million gross tonnage of ships were built which is 40% of the totality of ships in the world. In the manufacture of heavy and light machines, automobiles and rolling stock, Japan is ahead of all the countries. Orissa has huge mineral and water resources. The people are also talented and capable of hard work. We have not yet been able to make full use of these human and material resources.

The installation of two thermal stations of 5,000 kW each at Choudwar and Rajgangpur (though the latter was mainly for the cement plant) followed by the two hydel plants at Machkund and Hirakud, did much and would have done much more in the next five years, had there not been the temporary set-back caused by the Chinese and Pakistani troubles and the consequent change over to defence production along with the shutting down of imports.

A comparative picture of Orissa of 1936, and of Orissa in 1966 would further clarify the progress. Our State, which in 1936 had no industry worth the name, could by 1966, enlist and register 640 industries excluding rice and oil mills and *bidi* factories. A comparison of the total installed capacities of power generation and consumption per capita in 1948, in 1960, and today, may give us a picture of the development of industry in the State. 75% of this power is for industry. The figures are given in the table below.

Table 1

Comparision of total power generation and consumption per capita

Year	Total installed capacity, kW	Power consumed per capita, kWh
1948	4,500	0.5
1960	1,73,000	2,3
1966	3,15,000	5.0

Of course, compared to these, the all-India figures of 45 kWh per capita in 1960 and 80 kWh per capita in 1965 are staggering.

The promotion of many corporations is a good policy with great forethought. The Industrial Development Corporation for instance, has very most distinguished Institution in India with a membership of about 60,000. A premier Institution of the kind has no parallel in India. Members of all engineering professions including mining, metallurgy, electronics and surveying, have joined this Institution as members. The technical deliberations undertaken by this Institution are superb. Best brains, foremost builders, top research workers, all of very high reputation contribute papers to its journals. It is only by being members of this Institution that we know what is being developed on the technical side of any branch of the profession. A member affiliated to one branch is entitled to demand technical papers of any other branch. The small contributions that we pay, is comparatively nothing compared to the advantages one gets from being a member of this Institution. The membership of the Institution is almost 'a must' to every engineer to play a greater role in the development of his technical knowledge and to satisfy the natural urge in every one to become better and better.

To conclude, I would like to recall the wise words of Pandit Nehru, 'Fortune is a hostage which has to be zealously guarded by our own good work and which has a tendency to slip away if we slacken in our efforts or we look in a wrong direction5. There can be no good work for the Nation without hard work. Let us, therefore, dedicate outselves on this occasion to another year's hard and sincere work'.

Summaries of Papers Published in the Journal, vol. 46, no. 11, pts. CI 6, ME 6 and MM 3, July 1966

CIVIL ENGINEERING DIVISION

1. Design of Reinforced Concrete Grid Floors by Collapse-Load Method. M. Das, *Non-member*

The use of grid structures for covering large floor areas and for comparatively reduced headroom has become increasingly popular in recent years. However, the methods for analyzing these structures are found to be time-consuming and some require an advanced knowledge of mathematical analysis. This paper illustrates the collapse-load method for the design of R.C.C. grid floors, which is simple, gives a solution readily and does not require an advanced knowledge of mathematics.

2. An Investigation for the Prediction of True Ultimate Moment of Reinforced Concrete Beams. P. Desayi, *Associate Member,* **and C. S Viswanatha,** *Non-member*

Concrete has been observed to fail under a stress lower than that of its ultimate strength given by the usual compression test, for sustained loads of a sufficiently long duration. A knowledge of the magnitude of 'true' ultimate strength is a necessity for the evaluation of the safety and serviceability of a structure. This paper presents a method for the prediction of the 'true' ultimate strength of a R.C.C. beam.

3. Linear Analysis of Rainfall-Runoff Relationship. Dr. V. C. Kulandaiswamy, *Associate Member*

The paper presents a study of the relationship between rainfall excess and surface runoff by treating the rainfall excess as the inflow to and the surface runoff as the outflow from the basin, and assuming the relationship to be linear. The problem is stated as the one which determines the operation performed by the basin on the inflow to give the outflow. Using Laplace transform method, an expression is derived for the instantaneous unit hydrograph. The various assumptions underlying the existing instantaneous unit hydrograph theories and the approximations made in their development are also brought out. The need for making a greater use of the organizing and systematizing influence of mathematics in the study of hydrology of surface runoff is stressed.

4. Survey Adjustments by Digital Computer. K. K. Rampal, *Student*

Computers are finding increasing use in aiding man's efforts to solve engineering problems. This paper presents the use of an IBM 1620 computer, in the Indian Institute of Technology, Kanpur, to solve the problem of survey adjustments, which is often faced by a surveyor, due to errors in levelling, traversing, and triangulation

5. Theoretical Concepts of Pore Pressure in Soils. Dr. N. V. R. L. N. Rao, *Associate Member*

This paper presents a review of the various theoretical concepts in respect of the pore pressure in soil. The role of pore pressure estimation for engineering purposes and its validity is also discussed.

6. Temperature Efforts in R. C. Frames. Y. L. Sadana, *Associate Member* **and K. C. Verma,** *Associate Member*

This paper presents a method for the analysis of R.C.C. frames considering uniform temperature change in the beams comprising a frame. The temperature effect on columns, being negligibly small, is not considered. The other possible states of temperature affecting the frames have also been discussed. The theoretical aspect of evaluation of initial end-moments in case of steady state temperature of a beam or beams of the frame, which is sometimes likely to occur, has been indicated. The solved example also shows the method of finding out stiffness factors, carry-over factors and initial end-moments for members with two unequal sections. The method indicated is equally applicable for any other loading on the frame.

7. Economics and Constructional Advantages of Detour Canal Alignments. R. Satyanarayana Moorthy, *Associate Member*

The Nagarjunasagar Right Main Canal is one of the biggest canals in the world. With a head discharge of 21,000 cusec., it runs as a contour canal for 276 miles. The canal, in its run from Krishna to Pennar, crosses several hill ranges, major streams and valleys, giving scope for various alternatives to be examined. The alignment as finalized and provided for in the project report crosses ridges with tunnels and deep cuts and major streams by means of aqueducts and high approach embankments. The paper deals with how adoption of detour alignments has resulted in considerable savings in cost, besides facilitating construction with practically no foreign exchange required. This paper describes three typical cases to illustrate the advantages, and the design and construction aspects of the detour alignments.

8. Appraisal of Residential Properties in Assam. G. C. Sharma, *Member*

This paper discusses the method of valuation of residential properties consisting of houses, buildings and other appurtenances including the land in urban and cantonment areas of Assam mainly for rent control and uniform assessment of municipal tax purposes according to the Assam Urban Area Rent Control Act of 1961, based on the principle of modern valuation technique and engineering economics.

9. Study of Drainage Behind Lining in Irrigation Channels with Special Reference to Nangal Hydel Channel. Dr. H. L. Uppal, *Member* **and M. P. Singh,** *Non-member*

After the damage in the lining of the Nangal hydel channel in 1957, it was considered necessary to study the workability of a drainage system comprising open joined drains, continuous sand blankets, shingle filters, flap valves and weep holes laid during construction as a safeguard against the high subsoil water level in the cutting reaches. The data of subsoil water table along Nangal hydel channel from 1950-63 were collected. Day to day changes in subsoil water level in the cutting reaches corresponding to the variations in canal water level from January-June 1958, during the closure period in January 1964, and on re-opening of the canal in February 1964 were observed and examined in detail. The behaviour of canal lining during the closure period in 1963 and 1964 was also studied. This paper presents the details of the studies and the conclusions derived therefrom.

10. Ground Water Resources of Western Yamuna Canal (East) Tract. Dr. H. L. Uppal, *Member,* **and S. R. Sehgal,** *Non-member*

The role of deep tube-wells in augmenting food production is well realized in our country. For successful boring of such tube-wells, a thorough knowledge of the groundwater resources must be obtained beforehand. It has been generally assumed that the sand strata in the Punjab contain about 15% of water by volume. If the frequency of sand strata in the alluvium is taken as 30%, the average storage capacity of groundwater would be about 5 ft. per 100 ft. depth. This paper presents the details of experiments carried out in the Western Yamuna Canal (East) Tract, to obtain a more exact figure for the water storage capacity of the underground strata.

PRESTRESSED CONCRETE GROUP

11. Precast Prestressed Concrete Trussed Girder. Dr. K. K. Banerjee, *Associate Member,* **and K. D. Banerjee,** *Non-member*

This paper reports the findings of a study on N-type girders with compression diagonals and is the first of the series of several tests on different types of prestressed girders. The study includes tests on model and concrete prototype girders, measurement of strains and deflections due to prestressing and applied loads and estimation of secondary stresses that may arise on account of rigidity of joints. The test results have been also compared with the theoretical values. The behaviour of the structure at working and ultimate loads have been studied and compared with the conventional types of girders. The manufacture, assembly, prestressing and handling of the girders presented no difficulty and hence it is concluded that great future lies ahead for this type of girders.

RAILWAY ENGINEERING GROUP

12. Some Aspects of Selection, Design and Capacity of Diesel-Hydraulic Locomotives. V. A. Patel, *Associate Member*

This paper deals with the selection of a fleet of main-line and general purpose diesel-hydraulic locomotives designed to suit almost all duties. It presents an approach to the design of such a locomotive, giving a step-by-step worked out example. The main particulars of the locomotives have been worked out and the capacities for various duties, including the operation in a mineral railway, have been illustrated by Z_e -V and S-V diagrams and tables.

ROADS AND ROAD TRANSPORTATION GROUP

13. Study on Life Characteristics of Roads G. C. Sharma, *Member*

This paper describes the life characteristics of roads in Assam for earth, gravelled, metalled, bitumen grouted and black topped surfaces constructed, retired and remained in service for nearly half-a-century. An assessment has been made separately for the various elements of highways, *e.g.*, right-of-way and road embankment, roadway pavements, waterway structures and other miscellaneous appurtenances within the limitation of statistical data as far as available.

MECHANICAL ENGINEERING DIVISION

1. Mechanics of Drilling Process. S. K. Bera, *Non-member*, and Dr. A Bhattacharyya, *Associate Member*

The need for drilling a large number of holes is rather common in an engineering workshop. This paper presents a study on the mechanics of the drilling process, which enables efficient and economic planning of this work.

2. Determination of Tool Forces During Turning Operations by Tool-Force Dynamometers. N. C. Das, *Non-member*, and B. K. Mallik, *Associate Member*

For rational and efficient design of machine tools, a knowledge of cutting force characteristics is essential. This paper describes the methods for the experimental determination of the cutting tool forces by various types of turning dynamometers.

3. Kinematic Analysis of Quick Return Mechanisms. H. M. Ganesh Rao, *Associate Member*

This paper presents an analytical method for the determination of velocities and accelerations of the elements of a mechanism and its application to the synthesis of a quick-return mechanism of both the drag-link and the sliding-link type.

4. A Study of the Grinding Process During Z-Z Method of Application of Cutting Fluids. N. C Kundu, *Associate Member,* **J. Banerjee,** *Associate Member,* **B. P. Ghosh,** *Associate Member* **and Dr. A. Bhattacharyya,** *Associate Member*

Grinding, although the earliest known method of metal cutting, presents a large number of problems because of the random grit geometry, high speed of cutting and small depth of cut. The latter, combined with the high strain rate induces very high stresses in the shearing process and results in the development of high specific energy in a localized zone because of the size effect. An abnormally high temperature is reached at the cutting points, bringing home to several common troubles like excessive wheel wear, burning, surface cracking, residual stresses and in some cases a change in the micro-structure at the ground surface. This paper presents the investigation carried out to device a practical means of application of fluid on peripheral grinding as suggested by Bokuchava, and discusses the results obtained from the cutting tests for the forces, specific energy and the grit and work-surface temperature.

5. Nozzle Design: Prandtl-Meyer Expansion Method. B. S. Jagdish, *Non-member,* **and V. F Stepanchuk,** *Non-member*

This paper presents a method for the design of nozzle wall shapes. It is based on the principle of generation of Mach waves (Prandtl-Meyer expansion waves) which appear when supersonic gas expands about a corner and the resulting deflection of the steam lines. The nozzle wall contour is simple to obtain and may be practicable for use in rocket motors up to an expansion ratio of about 50. The various possibilities with one or more than one centres of expansions are discussed. A comparative study of the nozzle dimension based on the present method of design is made.

6. Anode Machining of Hard Metals by a Mild Steel Disc. A. Mukherjee, *Non-member,* **A. Ghosh,** *Non-member,* **and Dr. A. Bhattacharyya,** *Associate Member*

This paper presents a review of the work done in the field of anode machining in recent lines. It is well-known that when two metallic plates are placed in a conductive electrolyte bath and energized by a direct current, metal is taken out from the plate which acts as the anode and deposited on the cathode plate. The principle of metal deposition by this technique is extensively used in electroplating. But utilization of the reverse process, i.e., metal removal by electrolysis, is in a very infant stage.

7. Stabilization of Diffusion Flames by Opposed Jets. T. Mukherjee, *Non-member*, and M. Achuthan, *Associate Member*

This paper presents an investigation on opposed jet stabilization of diffusion flames. The diffusion flame, obtained by injecting burshane in a primary air steam, was stabilized by an opposing air jet. Theoretical analysis, based on a simple model, was carried out to derive a stability criterion based on the residence and the reaction times. Experimental investigation conducted to check the validity of the theory is found to give satisfactory agreement between theory and experiment.

8. Optimum Pressure in a two stage Reciprocating Compressor with Different Indices of Corporation. G. V. Ramanaiah, *Non-member*, and R. N. Reddy, *Student*

It has been generally accepted that the optimum pressure in a two-stage reciprocating compressor with or without intercooling is the geometric mean of the suction and delivery pressures, when the indices are assumed to be the same in both stages. But in practice the indices are often different in the two stages and the index of the high pressure stage is greater than that of its counterpart This is partly because the properties of the air itself change for higher pressures and temperatures. This paper deals with the optimum pressure for different indices of compression and the corresponding variation in other parameters.

9. Indian Standards for Limits and Fits. K. D. Sharma, *Associate Member*

This paper presents a comparative study of the recommendations of 'limits' and 'fits' in the British and the Indian Standard specifications, which are expressed in the F.P.S. and in the metric system of units respectively, to facilitate teaching in the engineering colleges of India.

10. Design of Traction-Pool Type Speed Variator. I. N. Singh, *Non-member*

This paper presents a design of speed variator for fractional h.p. motors. The speed ratio can be varied, while the motor is running, infinitely up to 25% of synchronous speed. The calibration of the speed variator has to be done experimentally.

11. Mechanism of Friction. Prof. R. D. Singh, *Associate Member*, and A. K Jha, *Non-member*

The force of friction is a function of the true area of contact of the mating surfaces, the normal load and the shear strength of the materials at junctions. The value of the coefficient of friction depends upon a number of variables like area of contact, normal load, the surface roughness, velocity of sliding and the atmospheric oxidation and lubrbication and it is known to change with the rise of temperature, mainly due to friction. In spite of intensive research much remains to be known about the nature of friction. This paper presents a review of the works carried out in the field of friction.

MINING AND METALLURGY DIVISION

1. Investigation into the Products of Pig Iron for High Grade Malleable Cast Iron and Spheroidal Graphite Cast Iron in an Experimental Hot Blast Cupola. K. C. Chowdhuri, *Non-member,* **and N. V. Pandit,** *Non-member*

This paper presents the experience gained from the working of a recuperative hot blast cupola unit installed at the Chittaranjan Locomotive Works, Government of India. The experiments have conclusively proved that it is possible to produce pig iron suitable for the manufacture of high grade malleable iron and that it is also possible to produce spheroidal graphite iron conforming even to the higher grades specified in IS : 1865-1961 by suitably treating the base iron melted in the hot blast cupola.

2. Dust in Mines. R. S. Mishra, *Associate Member*

Dust of all kinds has a nuisance value. It caused disease of the lung if a person is exposed to it for long period of time. To evade the lung disease caused by dust, it is necessary that the dust content of the air inhaled be reduced to a definite minimum value. The presence of dust in air also causes explosion of coal dust. This paper describes the various methods which have to be used to combat this dust menace.

3 The Notched-Bar Impact Properties of Silicon-Manganese Steel. D. V. Reddi, *Associate Member* **S. K. Dutta,** *Non-member,* **and P. S. Ramaswamy,** *Non-member*

This paper presents the determination of the impact properties of silico-manganese steel in tempered martensitic condition from 100-60°C. The transition temperature based on energy absorbed as well as fracture appearance is below 60°C. The data indicate that silico-manganese steel in heat treated condition is satisfactory for springs at low temperature as it suffers no embrittlement at temperature as low as – 60°C.

4. Training of Mining Engineers in Britain and in the United States. R. K. Singhal, *Non-member,* **and C. W. Berry,** *Non-member*

The advent of mechanization and the desire for having increased safety in the mining industry has created the need for a thorough scrutiny of the training of the prospective mining engineers in and out of the University. This paper presents a study on the methods adopted in the U.K. and the U.S.A. for the training of the mining engineers.

INSTITUTION NOTICES

Payment of Membership Subscription and Examination Fees

It is notified for information of the members that the facility of depositing membership subscription and examination fees has been extended to all branches of the State Bank of Bikaner & Jaipur and the State Bank of Mysore in addition to all branches of the State Bank of India. Payment should be made in cash at any branch of these banks in India by the bank-cards A and B.

Draft Indian Standards

The following draft Indian Standards have been issued recently.

1. Draft Indian Standard Specification for Steel Door Frames—Doc: BDC 11 (883).

This standard lays down the requirements regarding material, dimensions and construction of steel door frames for internal and external use.

Members may send their comments on this draft standard before July 31, 1966, to Shri T. S. Narayana Rao (*M.*), Consulting Architect and Engineer, 9 Mahatma Gandhi Road, Bangalore 1, who is the Institution representative on the Sectional Committee dealing with this draft Standard.

2. Draft Indian Standard for Safety in Excavation—Doc: BDC 45 (957)

This standard lays down the requirements for carrying out safely the excavation works called cuts, *e.g.* trenches, test pits, cellars, borrow pits, cuttings for rail and road formations and all excavations on which the sides of excavations are not trimmed, simultaneously to a stable slope.

Members may send their comments on this draft standard before July 25, 1966, to Prof. R. N. Dogra (*M.*), Principal, College of Engineering and Technology, New Delhi 16, who is the Institution representative on the Sectional Committee dealing with this draft standard.

3. Draft Indian Standard Code of Practice for Fire Safety of Industrial Buildings: Jute Mills—Doc: BDC 36 (1115).

This standard covers the essential requirements for the fire safety of jute spinning and weaving mills; jute rope and carpet making factories.

Members may send their comments on this draft standard before August 13, 1966, to Brig. N. B. Grant (*M.*), Director, Engineering R and D, Ministry of Defence, Kashmir House, New Delhi 11, who is the Institution representative on the Sectional Committee dealing with this Standard.

4. Draft Indian Standard Code of Practice for Composite Construction—Doc: BDC 32 (618).

This standard deals with the design and construction of composite structures made up of refabricated structural units and cast-in-situ concrete.

Members may send their comments on this draft Code before August 23, 1966, to Shri N. N. Purandare (*M.*), Consulting Civil Engineer, 24B Hamam Street, Fort, Bombay 1, who is the Institution representative on the Sectional Committee dealing with this Code.

5. Draft Indian Standard Specification for Hot Rolled Steel Channel Sections for General Engineering Purposes—Doc: SMDC 6 (680).

This standard lays down the nominal dimensions, weights and sectional properties of hot rolled steel channel sections for general engineering purposes.

6. Draft Indian Standard Specifications for Light Rails—Doc: SMDC 6 (729).

This standard covers requirements of light rail sections.

Members may send their comments on these Draft Standards before August 25, 1966, to Shri T. R. Mehandru (*M.*), 14 Asaf Ali Road, Ajmeri Gate Extension, New Delhi, who is the Institution representative on the Sectional Committee dealing with these Standards.

7. Draft Indian Standard Code of Practice for Installation of Internal Fire Hydrants in Multistorey Buildings—DOC: BDG 36 (933).

This standard lays down requirements regarding installation of fire hydrants in multistoreyed buildings.

Members may send their comments on this draft standard before August 25, 1966, to Brig. N. B. Grant *(M.)*, Director, (Engineering R and D), Ministry of Defence, Kashmir House, New Delhi 11, who is the Institution representative on the Sectional Committee dealing with this draft standard.

Copies of the draft Standards may be obtained from the office of the Indian Standards Institution, 'Manak Bhavan', 9 Bahadur Shah Zafar Marg, New Delhi 1, or from its branch offices at Bombay Mutual Terrace, Sandhurst Bridge, Bombay 7; 5 Chowringhee Approach, Calcutta 13, 14/69 Civil Lines, Kanpur, or 54 General Patters Road, Madras 2.

Application forms for Sections A and B of the Associate Membership Examination to be held in November 1966

Application forms for Sections A and B of the Associate Membership Examination to be held in November 1966, are attached to this issue of the Bulletin. Detailed instructions are attached with the application forms and they may be detached for reference, if so desired. Students are notified that no further application forms will be distributed to them.

Applications complete in all respects and accompanied by the examination fee for admission to the November 1966 examinations and one copy of passport size photograph pasted in the space provided on the application form should reach the Head Office before **4.00 p.m. on Thursday, September 15, 1966.**

Sections A and B of the Associate Membership Examination—Limitations to number of candidates at examination centres

The Examinations Committee have decided that the number of candidates appearing at any examination centre should be restricted to 750 only, in view of the difficulties experienced in making arrangements.

Candidates intending to appear in the examinations should mention in the examination application form the name of three examination centres in order of preference, and the Controller of Examinations will allot each candidate the centre at which he will be permitted to appear. Candidates who fail to mention more than one examination centre will be allotted any centre of examination at the discretion of the Controller of Examinations. No individual representations will be considered after the allotment of the examination centre is made.

Despatch of Admission Cards and Results of Examinations

Students are informed that Admission Cards and Results of examinations will be sent only to their addresses as registered by them in the Institution Head Office at Calcutta.

Rechecking and retotalling of marks

Candidates wishing to have their answer-books rechecked and retotalled must apply to the Controller of Examinations by name, enclosing a postal order for the fee to be paid for this purpose, along with the application. This will facilitate rechecking of answer-books. Remittance of money in any other form or without enclosing the postal order with the application, or applications to the Controller of Examinations not addressed by name, may result in unnecessary delay.

Transferring of Exemptions obtained in the Old Scheme of Examination (since discontinued) to the Existing Scheme of examinations

Candidates who have secured exemptions in subjects of the Old Scheme of examination held upto and including the November 1965 examinations, and desire to appear in the November 1966 examinations, may fill in the appropriate name of the subject(s) in the exemption column after consulting the list published in the December 1965 issue of the Bulletin.

Seminar on 'Engineering Industries and Their Development', 1968

At the 445th meeting of the Council held at Ootacamund on April 29, 1966, the Council resolved that 'at the forthcoming Annual General Meetings of Local Centres, the Local Centres may hold Seminars on a subject to be selected by the President, and an all-India Seminar be held on the same subject in 1968 at the 48th Annual Convention of the Institution. The President has subsequently selected the topic 'Engineering Industries and Their Development', as suggested by Prof. N. S. Govinda Rao, for the Seminar. The Seminar will be held concurrently with the 48th Annual Convention of the Institution in early 1968.

The Council also *resolved* that at the forthcoming Annual General Meetings of the Local Centres, the Local Centres may hold Seminars on the subject.

Further details of the Seminar, *viz.*, topics for discussion for writing papers, venue, time, etc., will be announced as and when available.

Publication of the Institution Year-Book

The Council at the 445th meeting held on April 29, 1966, recommended to the General Body of Corporate Members that the Year-Book, which was being published annually, should henceforth be published once in every three years, making a suitable change in its title.

Further, as the policy in regard to publication of the Year-Book is governed by Regulation 64, adopted by the Council on May 23, 1964, the convening of a Special General Meeting of the Corporate Members for the necessary amendment of this Regulation has been left to the President. The President will do the needful as early as possible.

INSTITUTION NEWS

India participates in Commonwealth Engineers Conference

The Conference of Engineering Institutions of the British Commonwealth has, during its sixth four-yearly meeting held in London from May 9-20, accepted the invitation extended by Shri B. P. Kapadia, President of the Institution of Engineers (India), to hold its seventh meeting in India in 1970.

Announcing this news on his return from London, Shri R. N. Banerjee, Secretary of the Institution of Engineers (India), considered the acceptance of our invitation as a fitting climax to the endeavours of the Institution to uphold the prestige of Indian engineering and her engineers amidst the comity of nations. The Institution will thus celebrate its 50th year in 1970 amidst the Indian and Commonwealth engineers.

The Commonwealth Engineering Conference was set up in 1946, on the initiative of the Councils of three premier Engineering Institutions in the U.K., to provide a forum in which the participating Institutions can exchange experiences and discuss ways to better perform their respective responsibilities. Its meeting places to date have been: London, 1946 ; South Africa, 1950 ; London, 1954 ; Australia and New Zealand, 1958 ; Canada, 1962 ; and London, 1966

The sixth meeting of the Conference was attended by representatives of the engineering Institutions of Australia, Canada, Ceylon, East Africa, India, Malaysia, New Zealand, Pakistan, Rhodesia, South Africa, Trinidad and Tobago, the U.K. and Zambia.

Topics discussed included relations with other engineering conferences, and means of collaboration between them ; also the organization of the engineering profession within the countries represented.

Regarding the qualification of professional engineers, everywhere the need felt was for academic preparation, practical training and responsible experience as an engineer. Corresponding consideration was given to the proper qualification of engineering technicians.

Recruitment to the engineering profession and the assessment of manpower needs were also discussed. Great emphasis was placed on the duty of the engineer to conserve natural resources as far as possible.

The Conference welcomed the new members: East Africa, Trinidad and Tobago, and Zambia. It also elected the Council of Engineering Institutions (U.K.)—incorporated on 3rd August 1965, by Royal Charter—as a constituent member. It may be mentioned that the above Council has been set up as a federation of thirteen British Chartered Engineering Institutions, fostering relations with Government, with national and international bodies and with the public.

The Conference meeting, divided into seven business sessions, were held in turn at the Headquarters of the four U.K. host Institutions, those of Civil, of Mechanical, of Electrical, and of Chemical Engineers ; at these, the chair was taken by Lord Hinton of Bankside, President of the Institution of Mechanical Engineers, London. Receptions were given by Prince Philip, Dean of Westminster Abbey, Vice-Chancellors of the Oxford and the Cambridge Universities, Lord Mayor of Coventry, among others.

445th Meeting of the Council, Ootacamund, April 29-May 1, 1966

The 445th Meeting of the Council was held at 'Tamilagam', Ootacamund, Madras State, on April 29, 1966. The Finance Committee met earlier on April 29, at 10.00 a.m. At 2.30 p.m. on April 30, Dr. G. P. Chatterjee, Chairman, Mining and Metallurgy Division, delivered a lecture on 'Defence and Food for the Nation—Fundamental Nature of the Problem'. After the Council meeting, the Engineering Education and Research Committee, the Convenors of the various Panels, the Division Boards and Examinations Committee also met. The Council members were taken round the places of interest in this hill station. On April 30, 1966, they visited the Kundah hydro-electric project which is being constructed with Canadian cooperation. Two photographs taken on the occasion are given below.

Fig. 1
The Council members assemble at Ooty

The President's Itinerary

Arriving at Bombay on June 25, 1966, from his tour of Europe, Shri B. P. Kapadia, President, halted for a day at New Delhi in connection with a meeting convened by the Union Ministry of Irrigation and Power, and arrived at Calcutta on June 30, 1966. Till July 7, he attended rigorously to the works of the Headquarters, and convened a meeting of the Headquarters Building Committee on July 5, 1966. On the same day, accompanied by Sarvashri T. P. Marik and S. K. Majumder, the present and the past Chairman of the Bengal Centre, Shri Kapadia waited on a deputation to Shri P. C. Sen, the Chief Minister, West Bengal, regarding governmental grant for the new Headquarters building.

LOCAL CENTRE ACTIVITIES

Durgapur Sub-Centre

The Fourth Annual General Meeting of the Durgapur Sub-Centre was held on November 28, 1965, at the Central Mechanical Engineering Research Institute, Durgapur. Prof. Humayun Kabir, who was the Chief Guest on the occasion, said in his address that heavy syllabus was harmful for engineering students as it did not help them to study their subjects intensively. The students acquired a superficial knowledge only. In order to maintain a uniformity of standard in engineering colleges in the country, Prof. Kabir called for rationalization of syllabuses.

Shri H. N. Sil, in his Chairman's address said, 'To meet the heavy demand for engineers required by the various development projects, several engineering and technological institutions have been established in various parts of the country during the past few years. More and more engineers are being produced by these institutions to cater for the needs of the country. But, these freshers from colleges are, in most cases, found to be not competent enough to take the responsibility they are entrusted with. These boys are deficient in basic knowledge and are, therefore, not capable of developing their power of independent thinking. The top-heavy syllabus which has been prescribed for the graduate course is too unwieldy for the teaching staff to manage and too vast for the boys to assimilate. As a consequence, the boys only learn a little of various subjects to complete the course which they are obliged to memorize without basic understanding in order to pass. It is, therefore, desirable that the syllabus should be so framed that it may give more emphasis on basic knowledge. To effect that it may be found necessary to delete a few items of the existing syllabus involving higher knowledge which the students may pick up later.

Now-a-days emphasis is given by employers to engage engineers holding first class degree, with the idea that they will prove better and more efficient in service. But, actually the expectation does not come true after the selection is made. The reason is not far to seek. Unless the standard is brought to the same level in all the engineering institutions throughout the country, proper assessment or merit of boys at the time of selection is very difficult and liable for misjudgment. The Institution being a representative body of the profession, may use its good office to bring about the uniformity in standard by making a move in proper quarters.

There is now a growing tendency to utilise the services of engineers in key positions in all industrial concerns. This is a move in the right direction. But there is much to be desired as yet regarding the proper utilization of the services of these engineers' work only, the country is losing valuable man power who could help in developing the country in future with their own initiative and original creative ideas.

Also, to get the best out of the engineers, there is need for improvement in service conditions. This is a complex matter, which needs careful handling by some well organised representative body like the Institution.

Another vital matter is the language question which, I feel, has not received due attention of the engineers. There has been a strong agitation lately by some politicians to introduce an Indian language as the medium of university education in replacement of English. What effect this change will have on technological education needs careful consideration by the engineers. It is a plain fact that there are few books in Indian language on engineering subjects available in the market at present. In the event of a change-over from English to some Indian language without adequate provision of necessary text books, technological education in this country is sure to suffer a serious set-back, and as a consequence the progress of the country will be severely jeopardized. In the interest of the development of our country and in the interest of the engineering profession, we cannot allow this matter to be decided by some linguistic chauvinists. We have to recognise the fact that the moulding of the future shape of our country is primarily a responsibility of the engineers and so we have to be constantly alert and vigilant to avoid any untoward set back due to any lapse from our side'

FORTHCOMING EVENTS

Symposium on 'Ground Water Studies in Arid and Semi-Arid Regions', Roorkee, October 27-29, 1966

Under the joint auspices of the University of Roorkee and Geological Society of India, a symposium on 'Ground Water Studies in Arid and Semi-arid Regions' will be held at the University of Roorkee from October 27-29, 1966. The Symposium will give an opportunity for the scientific workers to get together and to discuss problems of mutual interest.

The sessions are proposed to be divided broadly into the following topics:

1. Geological Studies of Ground Water Occurrences in Hard Rock Areas
2 Geological Studies of Ground Water Occurrences in Alluvial and Sedimentary Tracts
3. Techniques and Problems in Water Well Drilling
4. Ground Water Flow and Well Hydraulics

5 Geochemical and Biochemical Studies of Ground Water
6. Geophysical Techniques in Ground Water Surveys
7. Future Research and Survey Programmes in Ground Water

All participants intending to present papers are requested to send before August 15, 1966, the title and brief synopsis of their papers, incorporating its salient features and conclusions. The complete text of the paper, in duplicate, should reach Roorkee by September 15, 1966, in typewritten form ready for publication along with illustrations, maps, etc., in black and white.

Further details can be obtained from Dr. R. S. Mithal, Professor and Head of the Department of Geology and Geophysics, University of Roorkee, Roorkee.

Symposium on 'Construction Costs', New Delhi, November 1966

The National Buildings Organization and the Regional Housing Centre for the Hot and Arid Zones of ECAFE are organizing a Symposium on 'Construction Costs' to be held in New Delhi in November 1966. The Symposium will focus the attention on the various aspects of the schemes of cost reduction. Discussions will be held under the following heads.

1 Effect on construction costs due to advance planning, phasing and continuity of work load.
2. Cost reduction through rational architectural planning and structural planning and structural design.
3 Scope of cost reduction through research, standardization, mechanization and use of new and improved building materials.
4. Cost reduction through management control, organization and integration of different stages of construction.

Members who wish to contribute papers may send the complete manuscripts to the organizers before August 30, 1966. Further details can be obtained from the Director, National Buildings Organization, Nirman Bhawan, Maulana Azad Road, New Delhi.

Symposium on 'Community Water Supply and Waste Disposal', Nagpur, December 1966

The Central Public Health Engineering Research Institute will hold a Symposium on 'Community Water Supply and Waste Disposal' at Nagpur in December 1966. This will offer an opportunity for different groups of peoples concerned with and responsible for community water supply and waste disposal to discuss in detail the various aspects of the problem. About 80-90% of the Indian population live in small communities and the problems of their sanitation are of utmost importance and require immediate attention of public health engineers and scientists. By constant research and attention, it will be possible to evolve simple and economic water supply and waste disposal systems suitable for them.

In places where no sewerage system exists, disposal of night-soil presents a problem. It is necessary to develop cheap and hygienic methods of disposal of night-soil.

In view of the present food scarcity in the country, composting of town and community refuse by mechanical methods is of urgent concern for public health engineers.

To stimulate the interests of the communities which do not at present have water supply and waste disposal facilities and to provide information that is available with those who have already executed such projects, the following subjects have been proposed for the Symposium

1. Community Water Supply
2. Community Waste Water Disposal
3. Night-Soil Disposal
4. Composting of Refuse

Papers are invited on these topics. Members who wish to contribute papers should submit a summary and two copies of the full paper, which should not exceed 3,000 words, to the Convenor before September 1, 1966.

Further particulars can be obtained from Convenor, Symposium Central Public Health Engineering Research Institute, Nehru Marg, Nagpur.

30th Annual Conference of the Water Pollution Control Federation, Kansas City, September 25-30, 1966

The 39th Annual Conference of the Water Pollution Control Federation will be held in Kansas City, Missouri, U.S.A., from September 25 to 30, 1966. The technical programme will be composed of 2 half-day general sessions and 20 half-day concurrent sessions in which the following subjects will be discussed: Pesticide Pollution; Missouri River Basin Management; Collection System Maintenance; the Great Lakes—Past, Present and Future; Treatment Plant Design, Sewer System Engineering and Construction; Regulation of Stormwater; Metro Systems; Stabilization Pond Systems; Plant Operations Research; and Advance Waste Treatment

Three half-day research symposia will also be held. Among the subjects from which papers will be chosen are: Stabilization Ponds; Analytical Procedures; Instrumentation; Activated Sludge, Anaerobic Digestion; Sludge Concentration and Handling Systems Analysis; Algae Problems; Chemical Treatment, Advanced Waste Treatment, Estuarial and Oceanographic Problems; Oxygen Transfer; and Solids Operation. An exhibition of over 150 latest products and processes for the field will be held at the Municipal Auditorium.

Further information can be obtained from Water Pollution Control Federation, 3900 Wisconsin Avenue, Washington D.C. 20016, U.S.A.

Seventh International Water Supply Congress, Barcelona, October 3-7, 1966

The International Water Supply Association will hold the Seventh International Water Supply Congress in Barcelona, Spain, from October 3 to 7,

1966. The objectives of the Association, forwarded in 1947, are to secure concerted action in improving the knowledge of public water supplies, to secure a maximum exchange of information on research and on methods of supply of water, and to encourage intercourse and better understanding between men engaged in the public supply of water. It is expected that the seventh congress will be attended by officers of public water supply undertakings from all parts of the world.

The scientific programme will include submission of general reports for discussion, presentation of special papers, a lecture on 'Limnology and Its Application to Potable Water Supplies', discussion on pollution of surface waters, a 'Corrosion Day' programme comprising presentation and discussion on six papers, a special session on water supplies on developing countries, and meetings of chemists and biologists. One of the features of the Barcelona Congress will be the International Exhibition of waterworks equipment and services.

Further details and application forms can be obtained from the International Water Supply Association, 34 Park Street, London W.1.

BOOK ACKNOWLEDGMENTS

1. **Text Book on Surveying.** S. K. Husain and M S. Nagraj. *Saroj Prakashan*, Allahabad, Rs. 9.50, 1965, 642 pages.

This book in metric system of units deals with chain surveying, compass surveying, levelling, contouring, plane tabling, theodolite surveying, minor instruments, curves and setting out of works.

2. **Public Health Engineering.** S. K. Husain. *Saroj Prakashan*, Allahabad, Rs. 8, 1965, 330 pages.

This book deals with the Water Supply Engineering and Sanitary Engineering in F.P.S. and metric units. It contains many examples, diagrams and exercises.

3. **Overseers' Duties and Accounts.** S. K. Husain *Saroj Prakashan*, Allahabad, Rs. 4, 1965, 166 pages

This book is written as a guide to the overseers working in Government departments. Various standard and prescribed forms have been explained in the book.

4. **Fundamentals of Engineering Geology.** R. S. Khurmi. *Dhanpat Rai and Sons*, Delhi, Rs. 9, 1966, 218 pages.

In various chapters of this book, the author has briefly dealt with physical geology, structural geology, mineralogy, petrology, stratigraphy, earth movements and volcanic activities, civil engineering geology, economic geology and field geology.

5. **Treasures of R.C.C. Designs.** S. Kumar. *Standard Book Depot*, Delhi, Rs. 14, 2nd edition, 1965, 581 pages.

This book explains with a practical bias, the designs of R.C.C. structures, especially the portal frames and multistoreyed building structures.

6. **Surveying and Field Works—Vol.** 1. B. C. Punmia. *Standard Book Depot,* Delhi, Rs. 11.50, 1965, 468 pages.

This volume of the book covers the common operations in plain and geodetic surveying, and includes a large number of illustrations and problems.

7. **Building Construction—Vol.** 1. S. C. Rangwala. *Charotar Book Stall,* Anand, Rs. 10, 1966, 352 pages.

This volume of the book deals with the various aspects of building construction.

8. **Building Construction.** S. Kumar. *Standard Book Depot,* Delhi, Rs. 14, 1965, 532 pages.

This book contains besides the treatment of various aspects of building construction, emphasis on the use of modern construction techniques in building industry.

9. **Building Materials.** N. Chowdhuri. *S. Chand & Co.,* New Delhi, Rs. 7, 11th edition; 1965, 164 pages.

This book deals with the various engineering materials used in building industry.

10. **Engineering Materials.** N. Chowdhuri. *S. Chand & Co.,* New Delhi, Rs. 12.50, 6th edition, 1965, 268 pages.

This book deals with building materials, lubricants ; ferrous and non-ferrous metals and alloys; electrical materials, etc.

11. **Basic Calculus.** N. Chowdhuri. *S. Chand & Co.,* New Delhi, Rs. 2, 20 pages

This book deals with the basic aspects of Calculus in 20 pages.

12. **Structural Theory and Design.** N. Chowdhuri. *S. Chand & Co.,* New Delhi, Rs. 15, 2nd edition, 1960, 312 pages.

It is a preliminary book on subjects of Theory of Structure and Strength of Materials.

13. **Railways** N. Chowdhuri. *S. Chand & Co.,* New Delhi, Rs. 7.50, 2nd edition, 1963, 126 pages.

This book deals with the various aspects of railway engineering.

14. **Modern Lettering Styles.** N. Chowdhuri. *S. Chand & Co.,* New Delhi, Rs. 2, 3rd edition, 1962, 20 pages.

This book describes the engineering and architectural lettering styles in 20 pages.

15. **Engineering Economics—Vol. 1.** T. Chand. *Nemchand and Bros.,* Roorkee, Rs. 11.25, 6th edition, 1964, 551 pages.

This book outlines the general economic principles, industrial laws, industrial organization, contracts, specifications, etc.

16. **Engineering Economics—Vol. 2.** T. Chand. *Nemchand and Bros.,* Roorkee, Rs. 12.50, 2nd edition, 1965, 689 pages.

This book deals with the operations of an industrial organization, and the fundamental principles of management that lead to effective coordination and control.

PUBLICATIONS RECEIVED

1. A copy of The Indian and Eastern Engineer, 107th Anniversary Number, edited by Mick de Souza and S. K. Ghaswala, has been received from The Indian & Eastern Engineer Co. Ltd., Sohrab House, 235, Dr. Dadabhai Naoroji Road, Bombay 1

This elegant Annual measures up to the proud heritage of the premier journal of India. 'Engineers..... are the true builders of new India', says Prime Minister Indira Gandhi in a message to this Journal: to the engineer-journalist devolves the duty to enhance the engineers' mental horizon. The makers of this issue live true to the expectation.

As Shri B. P. Kapadia, President of the Institution, puts it, 'No single publication has done so much for the country in spreading Engineering knowledge'. This issue comprises of sections on Electrical Technology, Materials Engineering, Civil Engineering, Applied Geophysics, Mining Engineering, Aeronautics, Chemical Engineering and Metallurgy, Marine Engineering, Scientific Research, Standardisation and Productivity, and Consultation and Management.

Besides the authoritative articles in each section, the Editorial, 'Advancing Frontiers of Technology' is a gem of technical enquiry by Shri S. K. Ghaswala. Presented in an excellent format and priced at Rs. 10.00, the 107th Anniversary Number is an invaluable possession to any engineer.

2. A copy of the publication entitled 'The Super 12% Cr Steels' has been received from Communication Corporation, U.S.A. The publication deals with the fundamental effects of alloying elements, commercially produced grades and specifications, applications, physical properties, mechanical properties, thermal stability, resistance to corrosion and oxidation, and processing and fabrication of the super 12% Cr steels.

3. A copy of the report of the study group on 'Efficiency and Economy in the Irrigation and Power Sector', has been received from the Central Water and Power Commission, New Delhi. The report includes chapters on the investigation, design and estimate up to pre-construction stage; construction, developments of irrigation and power benefits; coordination of knowledge and experience and improving the instruments of control and planning; organization, personnel and attitude; and various appendices

4. A copy of the publication entitled 'B.I.M.C.A.M. Handboow 1965-66' has been received from the British Industrial Measuring and Control Apparatus Manufacturers' Association, London.

5. A copy of the publication entitled 'Directory and Buyers' Guide for Compressed Air Equipment', has been received from the British Compressed Air Society, London.

6. A copy of the publication entitled 'Multilingual Glossary of Industrial Diamond Terms' has been received from Industrial Diamond Information Bureau, London. The glossary includes industrial diamond terms in eight languages *viz.*, English, German, French, Dutch, Italian, Spanish, Swedish, and Japanese.

7. A copy of the publication entitled, 'Modern and Prototype Conformity Vol. 1,' has been received from the Central Water and Power Research Station, Poona. The publication contains 23 papers which were contributed for the symposia (January 23-25, 1966) held to mark the completion of fifty years of functioning of the Central Water and Power Research Station, Poona. These papers deal with the subjects of great importance in hydraulics and allied fields, and classify themselves broadly into fluvial hydraulics, hydraulic structures and miscellaneous sections.

8. A copy of the publication entitled, 'Modern Trends in Hydraulic Engineering Research—vol. 2', has been received from the Central Water and Power Research Station, Poona. This publication contains 54 papers which were contributed for the Symposia (January 23-25, 1966) held to mark the Golden Jubilee celebration of the Central Water and Power Research Station, Poona. These papers on hydraulics and allied fields are also of great importance and classify themselves into fluvial hydraulics, fluid mechanics, maritime hydraulics, hydraulic structures, hydraulic machines, instrumentation, and miscellaneous section.

OBITUARY

The sympathy of the Institution is extended to the relatives of those whose passing is recorded here

Shri B. D. Goyal

Shri B. D. Goyal, M.I.E., died on January 15, 1966

Born at Muzaffarnagar on February 20, 1904, Shri Goyal obtained Assistant Engineer's Certificate from Thomason College of Civil Engineering, Roorkee in 1927. During 1927-28, he completed the practical training in the Irrigation Department of the Government of U.P. During the years 1928-44, he served as an Assistant Engineer in the same department. He was promoted to the rank of Executive Engineer in 1944 and was responsible for survey, design, and construction of channels, tubewells, and canals, etc. He was then promoted to the rank of Superintending Engineer in 1954. He also worked as Director, Refresher Courses, University of Roorkee for quite a long time.

Shri Goyal joined the Institution as Student in 1928 and later transferred to Associate Membership in 1932. He became a Member in the year 1952.

Shri A. R. Venkatachari

Rao Bahadur A. R. Venkatachari, B.E., M.A.S.C.E., M.I.E., died on May 19, 1966.

Born on June 21, 1895 at Tanjore, Shri Venkatachari, obtained his B.E. degree from Madras University in 1917, and stood first in the University. He worked in different capacities in the Public Works Department, Madras, and was responsible for construction of various buildings, roads, etc. He retired from the post of the Chief Engineer in 1954. In 1955, he was awarded *Padma Bhushan* by the President of the Republic of India.

Rao Bahadur Venkatachari joined the Institution as Member in the year 1948.

Shri D. P. Malhotra

Shri Dharam Paul Malhotra, B.E., A.M.I.E. died in a recent air crash.

Born in 1923 at Mirpur, Kashmir, Shri Malhotra obtained his B.E. degree in civil engineering from Bombay University in 1944. During the years 1944-50, he worked as Assistant Engineer, in P.W.D., Kashmir. In 1950, he was promoted to the rank of Executive Engineer. He was responsible for construction of hill roads and execution of a number of different types of major building projects.

Shri Malhotra joined the Institution as an Associate Member in 1960. He was the Honorary Secretary of Jammu and Kashmir Centre during the years 1963-65.

Shri J. C. Das

Shri Jogi Chandra Das, B.E.E., A.M.A.E., A.M.E.E., A.M.I.E., died on June 9, 1965.

Born in 1909, he obtained his diploma (A.M.E.E.) in electrical engineering from College of Engineering and Technology, Bengal, in 1938. In 1948, he passed the special degree examination in electrical engineering from the same college. During 1938-40, he worked as an engineer in Messrs. Ganguli and Chatterjee Ltd. During 1941-47, he worked as Chief Engineer in the Jessore Electric Co., Jessore. He then served the Motor Machinery Co., and Dalmia Co. Later, he joined the Jail Industries, Government of West Bengal.

Shri Das joined the Institution as Associate Member in 1952.

Shri J. N. Roy

Shri Jagadindra Nath Roy, B.Sc. (Hons.), B.Sc. (Eng.), A.M.I.E. died on March 7, 1966.

Born in 1912, Shri Roy obtained his B.Sc. (Hons.) degree from Calcutta University in 1932. In 1934, he graduated in Civil Engineering, and also obtained the diploma in Municipal Engineering from London University. During 1934-36, he completed his training. During the years 1939-45, he served as a Lecturer in Calcutta University and later served as Assistant Engineer in various organizations where he was responsible for execution of important works. During 1953-56, he served as an Executive Engineer in Burma. He then joined the Jalpaiguri Polytechnic Institute as Head of Civil Engineering Department, and later he became its Principal in 1960.

Shri Roy joined the Institution as Associate Member in 1949.

COMMITTEES OF LOCAL CENTRES AND SUB-CENTRES 1966-67

Uttar Pradesh Centre

Please add the following names to the list published on page 12 of *Bulletin* dated April 1966.

N. N. G. Dastidar
Brig. S. B. Jambusarwalla

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, industrial and other organisations employing engineers. It is hoped that employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta 20, except where otherwise stated.

YOUNG B.E. (Civil), A.M.I.E. (India), with good academic career and 12 years experience in planning, estimating, drafting specifications, scrutiny of tenders and actual construction of one major hydro-electric power project and one (the biggest) thermal power project of Central India and having been directly in-charge of masonry and concrete works, fabrication and erection of large quantities of structural steel including coal bunkers, gates and penstocks, heavy machines foundations, large and medium sized townships with associated service facilities and surveys and other civil works of several H.T. transmission lines and major grid sub-stations, seeks a suitable and immediate change (Office ref. 235).

METALLURGICAL ENGINEER, 23, from Indian Institute of Technology, Grad. I.E. (India), having some experience in Heat Treatment, also doing Section B (Mechanical Engineering) desires a suitable job in Foundry or Heat Treatment Shop (Office ref. 236).

INSTRUMENTATION SUPERVISOR, age 23, passed section A of the A.M.I.E. exmainations, and B.Sc. with Physics, Mathematics and Chemistry in 1962, having nearly four years training and working experience in electronic process control instruments at present engaged in a big oil concern in modern Electronic process control instrumentation and telementry in Assam; ready to serve anywhere as Instrument Engineer or Supervisor with suitable pay. (Office ref. E.S. 237).

BRILLIANT ENGINEER, B.Sc. (Hons.) (Civil Engineering), M.Sc. (Structural Engineering) (London), A.M.I.E., age 40 years with 5 years Planning and Design experience with Railways and Consulting Engineers in the U.K., and 11 years in Planning, Design and Construction experience of Fertiliser Projects, Power Stations, Bridges and Multi-storied Buildings in India seeks posiion as Chief Engineer. (Office ref. E.S. 238).

MECHANICAL ENGINEER, 28, B.Sc., Grad. I. Mar. E., passed Sections A and B of the Associate Membership examination of the Institution of Engineers (India) with Mechanical Engineering subjects, having 5½ years experience out of which 3 years in responsible position in maintenance and overhauling of main propulsion machinery of high powered steam and motor vessel, repair and maintenance of boilers, steam and electric driven auxiliaries, *e.g.*, compressors, pumps, refrigerators, etc., seeks suitable post. (Office ref. E.S. 239).

YOUNG ELECTRICAL ENGINEER, Grad. I.E., age 24 years, possessing First Class Diploma in Electrical Engineering with distinction in Power Group and passed Sections A & B of A.M.I.E. examination with electrical engineering papers (with Electric Power and Electric Traction as optional) and also passed 6 papers of A.M.I.E. in Mechanical Engineering. Prize-winner for best paper in electrical engineering in Delhi Centre, having 4 years experience in Design, Planning, Estimation, Erection and Maintenance of electrical installations in residential premises, offices, workshops, including lifts, power wiring. substations, etc. Hard-working, stout, energetic and of active habits with sobre nature. Seeks a suitable challenging position with guaranteed bright future in leading industries. Jobs with pre-specialization training programmes will be appreciated. (Office ref. E.S. 240).

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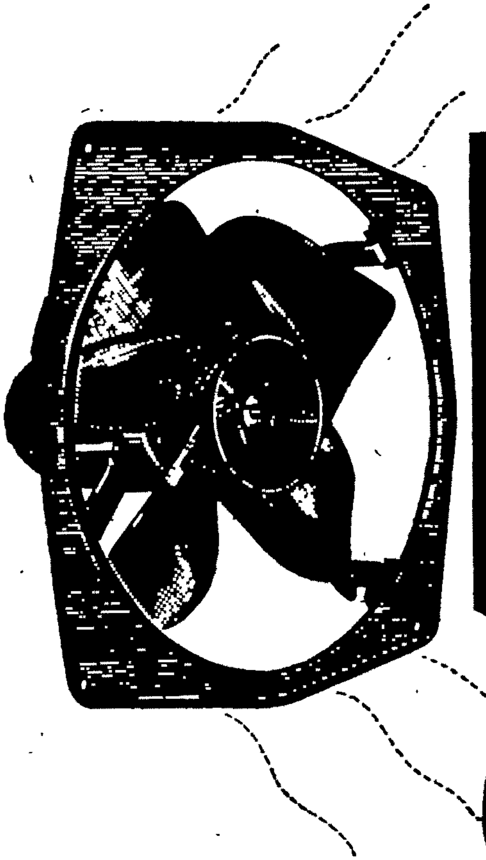

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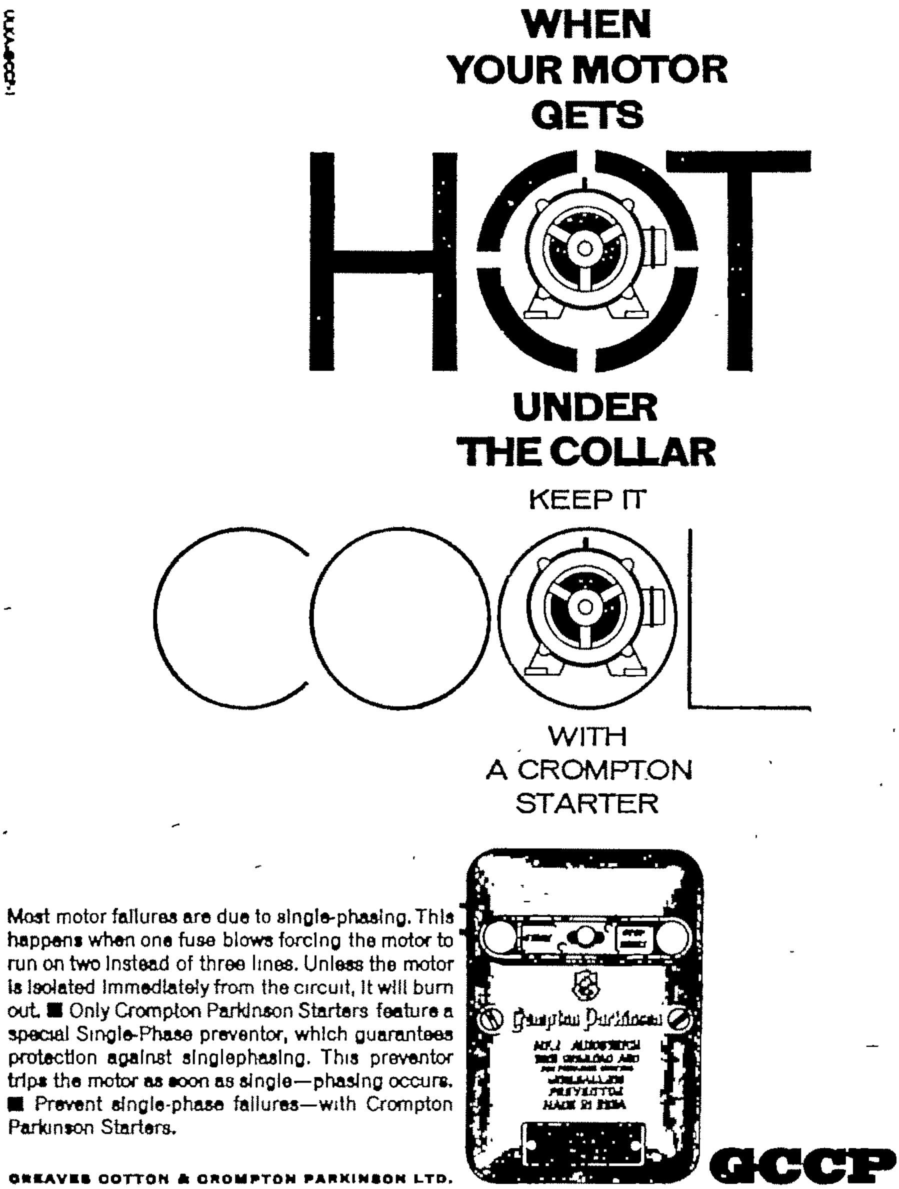

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Form 362

THE INSTITUTION OF ENGINEERS (INDIA)

8 Gokhale Road, Calcutta 20

November 1966 Examinations

General information and instruction to candidates

(Approved by the Examinations Committee, 51st Meeting, Resolution 21, 30th December, 1958)

(Revised by the Examinations Committee, 57th Meeting, Resolution 19, 27th-29th June, 1961, and 58th Meeting, Resolution 10, 13th and 14th October, 1961).

(1) The next Associate Membership (Sections A and B) Examinations will be held in November 1966, the programme of which will be announced in the August 1966 *Bulletin* The application forms for the Associate Membership (Sections A and B) are attached to this *Bulletin*.

(2) **All applications accompanied by examination fees for admission to the November 1966 examinations should reach the Head Office before 4.00 p.m. on Thursday, September 15, 1966.** Examination fees once paid are neither refundable nor transferable to a subsequent examination or to any other account. Receipt of examination forms will not be acknowledged by the Head Office, unless accompanied by a self-addressed post-card.

(3) **Examination fees should be preferably deposited at the State Bank of India in the candidate's locality. Attention of the candidate is specially drawn to item 3 in Form 363 and item 5 in Form 364 in this regard. The instructions for making such payment are given in Card A (attached herewith) and on its reverse. Other modes of payment may be used only if this is not possible. Payment of examination fees by cheque, postal orders or money order will not be accepted.**

Mention the code number as given in the top of the application form in the bank card.

(4) No application for a change of examination centre will be entertained after 4.00 p.m. on Thursday, September 15, 1966.

(5) Students who are in arrears of subscription will not be admitted to the examinations.

(6) **The Institution reserves the right to reject incomplete or illegible applications without any reference to the candidate.**

(7) No Student will be permitted to appear in the Section B examination unless he has fully passed the Section A examination or secured exemption therefrom. A candidate for the Section B examination should therefore mention the year in which he passed the Section A examination.

(8) Students appearing for the Section B examination under the revised rules 17(a) to 17(i) of the rules of examinations (see Rules and Syllabuses of Studentship and Associate Membership Examinations) should clearly state in the application form the name of the Local Centre to which they are attached.

(9) A candidate who has already passed the Section A and B examinations or is exempted therefrom will be permitted to appear in any paper or papers of Section A and/or Section B on payment of an examination fee of Rs. 50.00 per paper. The details of passing the Section A and B examinations or of exemption therefrom should be clearly stated in the examination form, with the grade of membership.

A candidate may also appear in one complete branch of engineering on payment of usual examination fee of Rs. 75.00. Rules of examination for such a candidate will be identical with those applicable to regular candidates.

(10) The Design and Drawing papers are of 5½ hours duration, with a one-half hour recess between. Candidates will not, however, be permitted to leave the examination hall.

(11) Candidates are not permitted to use handbook(s) for the paper in 'Design and Drawing' of Section B. They may, however, use steel tables of the Dorman-Long type.

General information and instruction to candidates (*contd.*)

(12) Candidates detected using unfair means in the examination hall will be expelled from the Institution and will not be re-admitted to the Institution at any future time.

(13) Candidates reappearing in subject(s) in which they have already secured exemption(s) will have their paper(s) cancelled. The previous exemption(s) will stand.

(14) It is sometimes found that candidates do not enter their Studentship Number, Roll Number, or other necessary particulars on the answer-books. Such answer-books will be rejected and no attempt will be made to locate the candidates. Candidates should therefore take particular care to write down these particulars on the answer-books correctly.

(15) The results of the November 1966 examinations will be declared before the last day of February, 1967.

(16) Candidates will be permitted to apply for the checking of their answer-books as to whether the marks allotted in the answer-books were added correctly and all the answers within the answer-books were appropriately marked, on payment of Rs. 5 as checking fees for each paper. Candidates wishing this check to be made should apply to the Controller of Examinations within 15 days of the date of posting the results by him.

(17) **The marks of each examination will be communicated to candidates along with results free of charge.**

(18) The Institution reserves the right to cancel the results of any candidate without assigning reasons in which case, the marks will not be supplied.

(19) In any future correspondence, in regard to the November 1966 examinations, candidates should always mention the Section of the Associate Membership Examination in which they appeared and their centre of examination in November 1966.

NOTICE

Detailed programme of the examinations will be announced in the August 1966 ***Bulletin.***

SOME MOST USEFUL ENGINEERING BOOKS

1.	**PRACTICAL ENGINEERING MATHEMATICS** by Prof. C. Dass Chawla (Latest revised and enlarged edition 1966) Combined Vol : ..	Rs.	21.00
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3.	**APPLIED ELECTRICITY** by S. P. Singhal (R.M.K.S. Units) ..	Rs.	12.50
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6.	**ELEMENTARY SURVEYING** by M. L. Nangru	Rs.	6.50
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9.	**STRUCTURAL ENGINEERING** by S. Ramamrutham . .	Rs.	13.75
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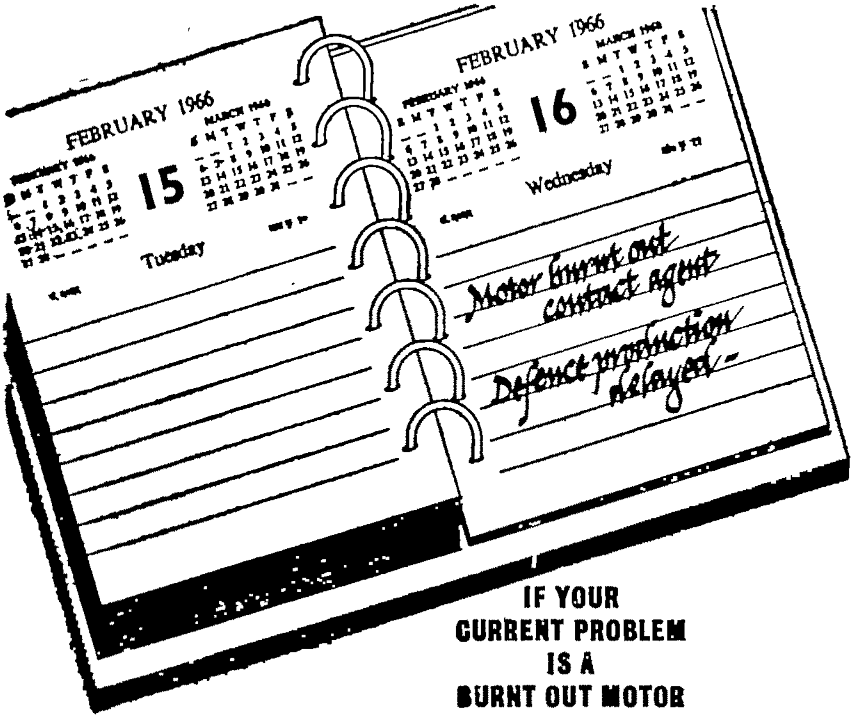

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THE BULLETIN
OF
The Institution of Engineers (India)

SECRETARY & EDITOR: Prof. R. N. Banerjee, B.E. (Elec.), M.S. (Mech.) (U.S.A.), M. Tex. A. (India), M.I.E. (India)

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INDIAN CONSULTING ENGINEERS—THEIR ROLE IN THE COUNTRY'S DEVELOPMENT

K. F. Antia
Council Member
Past Chairman, Bombay Centre
The Institution of Engineers (India)

1. The role of the consulting engineer

Indian engineers are called upon to shoulder the major responsibility in the industrial, defence, agricultural and other fields of development of the nation and the extent of progress made by the country depends to a great extent on their ability, initiative and industry. Engineers have to develop, design and construct numerous types of engineering works which impinge on countless activities of the citizens and they have to ensure the adequacy, efficiency and safety of all such works, whatever may be the discipline of engineering concerned. Engineers shoulder the responsibility not only of conceiving and designing all types of engineering works, plants for the production of numerous producer and consumer goods and process equipment but also of ensuring that they give satisfactory and economical results. With the vast technological developments of recent times, the designs, construction processes and products have become so sophisticated that it is difficult to achieve worthwhile results without specialization.

The consulting engineer specializes in one or more of the numerous engineering disciplines and confines his services to design, construction and advice on schemes pertaining to his field. Consulting engineer organizations are made up of the combined talent of specialists in various fields, which in addition to the various disciplines in engineering may include applied economics, management, marketing, transport, productivity, namely the optimum utilization of men and machines and production techniques. The suitability soundness and economic feasibility of any scheme depends on the judgment and skill of the consulting engineer.

The consulting units consist of specialists who (1) carry out field investigations and surveys for collecting relevant data, (2) undertake the preparation of reports to determine the feasibility of a project, (3) prepare project reports detailing the requirements and costs of a project, (4) prepare layouts of projects or plants, (5) select suitable sites for the location of the plant, (6) have site investigations carried out to determine foundation and other details, (7) arrange for preparation of the site for the requirements of the project, (8) prepare designs and detailed drawings of stuctures and utilities such as power, water supply, transport, etc., (9) prepare documents for inviting tenders and assess the results thereof, ((10) prepare specifications for machinery and equipment, (11) select, inspect and approve of these, (12) have tests carried out and advise on the performance of these, (13) check fabrication drawings of suppliers, (14) inspect structural components during fabrication, (15) prepare construction schedules, (16) supervise the erection of structures and plant, (17) undertake the supervision of the entire construction, (18) progress the work and certify the quantity and cost of work done and in the case of production units, (19) determine the type and number of personnel for manning the plant, and (20) advise on the operation of the plant. The consulting engineer's assessment and recommendation has a vital bearing on the cost and the economic feasibility of a project. Consulting engineer services must perforce be rendered competently and efficiently and mutual confidence is essential between the client and the consultant. Needless to say, such services have to be performed at a high ethical level. It will be appreciated that the interests of the client and the consulting engineer are identical as the client desires to establish a most economical and efficient project or plant and the consulting engineer's interest is to ensure this.

In case of industrial units, there are certain fields which do not come under the category of the consulting engineer service. An example of this is organizations set up by manufacturers for advice to purchasers of their machinery and equipment. Even though such service is sometimes specified as consulting service, it does not come under the definition as the advice rendered pertains to that particular equipment and independent comparison of other similar equipment is not available with a view to selecting the most appropriate and economic equipment. Moreover,, one of the essential requirements of consulting engineers is that they should not in any way be connected with commercial or manufacturing interests as this militates against independent judgment.

2. The necessity and advantage of consulting engineer service

Consulting engineers make a substantial contribution to the development of a country. The outstanding success of American industry in no small measure is due to such services. The necessity of such service in developing countries is even greater as the utilization of available resources and the application of new techniques and processes, developed both in the country and abroad, and the adoption of foreign methods to suit local requirements are best handled by consulting engineers. In some countries such as the U.S.S.R., design bureaus, which deal with one of the several aspects of consulting service exist on a large scale. In India similar design bureaus have also been established.

Science and technology have advanced to such an extent in all construction work that it is not possible to achieve optimum results without recourse to expert guidance provided by consulting engineers.

The consulting engineer undertakes the technical responsibility of a project and brings to bear on it the concentrated technical skill and experience and produces efficient and economical results. Even where an industrial organization has suitable technical staff, such staff is primarily for the operation and maintenance of the existing unit.

Moreover the work and experience of the technical staff of the organization may not be oriented towards design and construction and spare capacity to the extent required is not likely to be available. There is always the possibility of recruiting additional staff but apart from the fact that the results obtained from them would be the responsibility of those in charge, such staff would have to be absorbed in their organization or dispensed with at the completion of the project. No such problem arise if consulting engineers are appointed for the design and construction of the project.

For a correct assessment of the cost of projects handled by this method. indirect charges which should include the time spent by all existing staff, have also to be added and this procedure may be found to be less economical than the appointment of a consulting engineer.

The consulting engineer not only brings a fresh and objective outlook on the project but also the experience of specialists on various aspects of the project. He is also in a position to assess and select the most suitable out of several methods and processes and this has a considerable bearing on the success of the project.

An independent expert opinion from experts produce optimum results. For example, in the selection of the plant in case of industrial projects, the preparation of specification by consulting engineers not only forms the basis for obtaining the most suitable equipment but also provides a yardstick by which to compare the quality and performance of equipment from different sources, determine the most effective combinations of units from different suppliers and achieve optimum results.

The consulting engineer having handled similar projects, has at his command comprehensive data and deductions made from such data, and this is of considerable assistance to the project authorities.

Arrangements have to be made with leading organizations for financing a project and such organizations have to be satisfied as to the feasibility, economic advantage and financial gain from the project. The consulting engineer is in a position to present a rational report bearing on these points.

The layouts of an industrial plant has a considerable bearing on the efficiency and economy of production. The advice of experts on the most satisfactory location of various complexes making up the plant together with the location, distribution and magnitude of each of the various utilities well repays the relatively insignificant cost of the service. The repercussions of a faulty layout are far reaching and permanent and it is false economy not to legislate the aid of experts in this vital aspect of development.

The judicious grouping and amalgamation of manufacturing processes and equipment from different sources enables not only the best selection to be made but also harmonises the contribution of each unit for optimum results.

Specialized information is necessary in several fields for the establishment of any project and collection of such necessary information from several sources is both time consuming and uneconomical.

The consulting engineer has at his command a wealth of information on pertinent technical matters and his collaboration results in the tapping of this source of information.

Considerable reduction is possible in the time required for the preparation of feasibility reports, project reports and reports for financing bodies when such reports are handled by consulting engineers.

Numerous difficulties arise during the implementation of a project. Many of these difficulties which may lead to additional expenditure are due to avoidable technical shortcomings in design which would not be encountered if the project was entrusted to consulting engineers.

Free consulting service is sometimes offered by equipment suppliers. The bias in such service is necessarily for the utilization of their equipment and the client therefore does not have the benefit of an independent opinion, and may loose the advantage of installing a more suitable unit. In addition such service is not likely to provide expert advice on the design of the project as a whole. This disadvantage applies even in turnkey projects where the equipment supplier undertakes the responsibility for setting up of the plant and for the initial production. Although the results may be satisfactory so far as the main plant is concerned, many important utility items such as power and water supply, transport and numerous ancillary requirements are likely to lack expert design and supervision which will eventually affect results adversely.

3. Cost of consulting engineer service

The cost of consulting engineer service forms a small percentage of the cost of a project and in many countries, particularly in the U.S.A., it is considered an essential part of the project cost and has the same relevance as, for instance, the provision of transport or duties on equipment. The charges made by consulting engineers are usually in the form of a percentage on the cost of a project and covers the cost of highly qualified technical personnel, administrative staff, supplies and equipment, drafting and office space, travel, taxes and profit. For the preparation of reports, the quotation is generally in the form of a fixed sum.

Consulting engineers are also engaged on a retainer basis for advising on technical problems as and when they arise.

4. Availability of consulting engineer service in India

Indigenous consulting engineer service did not exist in India before Independence as the tempo of development and industrialization was slow and all consulting work was entrusted to foreigners. Government technical departments in particular used to refer all their technical problems to selected consulting engineer firms abroad.

With the increasing industrial bias after independence and the introduction and implementation of the Five Year Plans, the necessity of organizations for design and engineering of projects in all fields, and particularly the industrial field, has increased rapidly. The challenge has been taken up by engineers with foresight, enterprise and courage and the nucleus of such a service has been well established. The Government departments and public sector corporations have also established design units and some departments such as the railways, irrigation and power, and the roads wing of the Transport

Ministry have become self-sufficient. The absolute necessity for consulting engineer service is however still to be fully appreciated by some project authorities and entrepreneurs some of whom are inclined to consider it a luxury. Conviction of such a service being essential comes with experience particularly when it is ascertained that for example the cost of such service would have been a small fraction of the amount which would have been saved or the reduction in production cost which would have been possible through a more judicious selection of equipment or a better plant layout.

5. Procedure for obtaining consulting engineer service

The necessity and advantages of consulting engineer service having been appreciated and it is desirable to ascertain the best procedure for obtaining such service. The selection of the consulting engineer is one of the most important decisions in the conception and execution of a project. The technical knowledge, the experience, the skill, the capacity for sound judgment and the integrity of the consulting engineer are forcefully reflected in the soundness, efficiency and economic feasibility of the project.

In order to assess the best procedure for procuring efficient consulting engineer service, it is desirable to understand the forms in which consulting engineer establishments function. Consulting engineer firms may consist of proprietory establishments, partnership companies or limited liability companies. In India, consulting engineer units exist in all the three forms. There appears to be no restriction regarding the formation of even a public limited company but with such an organization the possibility exists of the control passing to persons whose major interests may be other than the rendering of the most effective technical service. In the U.K. the formation of public limited liability companies for consulting engineer units is not permitted It will be appreciated that the cost which is a small percentage of the project cost is not an all pervading factor in the selection of a consulting engineer. If, because of a poor selection, a wrong assessment is made in any of the numerous services required in a project, the cost to the project authorities may be considerably more than the saving effected in selection on the basis of comparative cost of consulting service. Appointment of consulting engineers on competitive bids is not likely to produce the best results as cost becomes the primary factor and this may vitiate against procuring the best service. It has to be appreciated that the advantages of competitive bidding are obtained only when the work required to be rendered can be rationally compared on the basis of specifications. Competitive bidding in consultancy service would imply that the capacity, the knowledge, the training, the skill of all those from whom bids are called, are equal. Moreover, consulting engineer organizations render entirely professional service such as those by physicians, or lawyers where competitive bidding is neither possible nor advantageous.

It is, therefore, in the interest of the client to obtain consulting engineer service by negotiations with one or more consulting engineer firms. This method lends itself also to assessing the relative merits of the firms with whom negotiations are carried out. A decision may also be made on the results of a report briefly assessing the project, which may be obtained from prospective consulting engineers. Such an arrangement is followed in a big way in the U.S.A. by their Defence Department, Bureau of Reclamations, numerous municipal organization, etc. It is also in the interest of the client to engage for engineering service, the consulting engineer who has earlier been entrusted with the preparation of the project report.

6. Advantages of obtaining consulting engineer service from Indian consultants

Because of the historical background, and the comparatively recent development of consulting engineer service in the country, the tendency has been and still is to import foreign consultants. Although, recourse to foreign consultants in a few fields where the know how is not available in the country may be an advantage, provided the know how is eventually imparted to Indian engineers by the foreign consultants, there are distinct and overwhelming advantages in entrusting all consulting work to indigenous talent.

The speed of development of the country can be increased if all design and engineering services are carried out by indigenous consultants as this generates increasing self reliance and diffusion of the requisite knowledge and experience. Even in cases, which should be few, where foreign know how is necessary, package deals should be avoided, as knowledge and experience are seldom gained by Indian engineers by this arrangement.

Indian consulting engineers have a more comprehensive knowledge of local conditions, the source and availability of utilities such as power, transport, water supply, etc. and this is of advantage in the design and execution of a project. Moreover, there are greater possibilities of processes suited to Indian conditions being adopted and of foreign processes being modified to give optimum results under Indian conditions. The preparation of specifications for plant and equipment are also likely to be oriented to the equipment available indigenously resulting in increased use of Indian manufacture and the resulting increase in industrialisation.

Another important consideration is the increase in the acquisition of know how which can be utilized for further projects and the building up of an extensive cadre of design and construction engineers with an increase in the number of consulting engineer establishments and their continuing expansion.

A vital consideration affecting the economy of the country is the saving of foreign exchange resulting from a reduction in the assignment of such services to foreigners. This sum has been estimated as a very substantial amount. Apart from reducing the drain on foreign exchange, the utilization of Indian consulting engineers will enable such services to be exported. This, in addition to earning foreign exchange, will result in gain for indigenous manufacturers as Indian equipment is likely to be encouraged by such consultants.

7. Handicaps of Indian consulting engineers

Indian consulting engineers suffer from various handicaps, the most serious of which is the tendency of project authorities approaching foreign consultants for service either through lack of information regarding equivalent service being available indigenously or because of a misplaced bias that anything foreign is superior to its Indian counterpart.

Another important inhibiting factor is the dearth in assignments to provide continuous work to groups of highly qualified technical personnel. Any hiatus between the completion of one assignment and the starting of another confronts the consulting engineer with serious financial problems and this perforce hinders development as retrenchment and re-employment of highly qualified personnel is an unsatisfactory and difficult proposition.

The consulting engineer has also to do a considerable amount of work in preparing and submitting proposals to prospective clients, for which he does not receive financial compensation. This also has an adverse effect on his financial staying power particularly as he normally does not have any significant reserves to tide over a lean period.

8. Possible measures for promotion of Indian consulting engineer service

The necessity and advantages of Indian consulting engineer service having been appreciated, it is desirable to ascertain the measures which may be adopted to consolidate and expand such service to the advantage of the country. For the promotion of Indian consulting engineer service the prime requirement is an appreciation in the country of the necessity and advantages of this service. As Government departments and public corporations handle a large proportion of all the projects in the country the assignment of all design and engineering services to indigenous consulting engineer firms in addition to design organizations of Government and autonomous corporations would form a most effective measure. Government authorities need have no anxiety in adopting this procedure as Indian consulting engineers have equitted themselves very creditably in fields such as iron and steel, entrusted to them.

It is however important to have the concept of consulting engineer service clearly understood. As already indicated, technical sales ogranizations of manufacturers which render very useful service in their own fields, should not be confused with consulting engineer service, as this is likely to give a distorted image of the service.

All feasibility reports and project reports required either by Government departments, autonomous public corporations or industrialists in the private sector may with confidence be considered to come within the purview of Indian consulting engineers.

Where some foreign know how is involved, it would be in the interest of the country and of authorities concerned to arrange necessary foreign collaboration through Indian consultants only. Moreover the assistance of consulting engineers with projects from their earliest stages would secure considerable advantage to the projects.

Some procedure by which constant assignment of work is made available to consulting engineers would lead to substantial promotion of indigenous consultancy work. One such method would be to ensure that no work which is within the competence of Indian consulting engineers is allocated to foreign consultants. Moreover, the requirements of consulting service in new fields might be made widely known by Government departments to consulting engineer organizations. Detailed design even in such cases should be entrusted to Indian consultants. All Government technical departments and autonomous public corporations need to maintain lists of consulting engineering firms and assignment of work might be advantageously made by the method indicated above. It is however important to ensure that such lists cover only those firms which come strictly under the definition of consulting engineers

Close association of consulting engineers with research stations is very desirable because of their capacity to assess the suitability of application of results of research.

In order to render efficient service, consulting engineers have to keep abreast of the latest technical advances in the world and encouragement of study tours and participation in conferences both in India and abroad are important requirement.

The consulting engineer service has rendered a good account of itself in its formation stages and, given the necessary facilities and incentives, there is no reason to doubt that it will bring substantial advantages in the development of the country. Consulting engineers are in a position to make a vital contribution in attaining technological independence for the country in a continuously increasing measure.

LAND DEVELOPMENT IN URBAN AREAS

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1. Rapid urbanization

Population growth and stagnation of the rural economy have made rapid urbanization precede rather than follow industrialization. The rate of migration from the rural sector will continue to increase and urbanization will be so fast as to touch the figure of 40% of the total population in 1981. This will pave the way for an exorbitant rise in urban land values, and, as the draft Memorandum of the Fourth Plan rightly puts it, 'In recent times, land values in urban areas have risen exorbitantly leading to a virtual exploitation of the community and serious hardship to the man of average means'. Housing will become a major problem in our cities. Along with it will develop other problems such as water-supply, sanitation, electricity, roads, drainage, etc. A sovereign remedy for this malady consists in public-land-acquisition well ahead, as, for example, has for many years been the policy of Stockholm, Rotterdam, and some European cities.

The responsibility of the State for bearing the 100% incidence of the cost of urbanization has been restricted by certain factors. In the first place, the economic development which we sought through our Five Year Plans have not been fully realized. During the First Plan, the national income rose by 18% as against the target of 11.5%. The Second Plan witnessed a rise of 20% in the national income as against the target of 25%. The Third Plan could not achieve even a 20% rise in the national income. In the second place, the per capita real income has not been sufficiently raised to ensure a fairly high standard of living. For instance, as compared to 1950-51, the national income rose by 42% in 1960-61, while the per capita income rose from Rs. 284 to Rs. 330 at 1960-61 prices, *i.e.*, by only 16%. Factors such as high birth-rate and high cost of living due to rapidly rising prices have stood in the way of the people obtaining a fairly high standard of living. Finally, a sustained growth at the present rate of growth may not be possible when urbanization reaches a steady level for the reason our national income has not been high enough to ensure sufficient savings to meet the cost of urban development.

The municipalities too cannot meet the cost of urbanization as their funds are inadequate for the purpose. Their per capita costs have gone up. Judging from the surveys by the *Reserve Bank of India Bulletin* (February 1959 and April 1958) disbursement by local authorities serving cities over 100,000 population as of 1951 probably doubled between 1952 and 1959. Expenditure in 1958-59 by 56 large municipalities came to about Rs. 940 millions. In terms of the 1951 population of around 22 millions, the per capita expenditure averaged about Rs. 43. The per capita figure for thirteen big city-corporations comes to about Rs. 57 The figure has moved up now

Hence the local bodies are finding it hard to provide substantial sums for urban development.

2. Remedy

The only way out consists in the adoption of a self-financing type of urban development. The scheme has to be based on six preliminary conditions, and these are:

(a) Abolition of private layouts in cities;

(b) Adoption of legislation for compensation for agricultural land;

(c) State planning for the provision of roads, electricity, water-supply and drainage;

(d) State monopoly in regard to creation of house site out of agricultural land;

(e) Change in the acquisition procedure and laws to suit the tempo of development; and

(f) The process of development to be distributed over a period of ten years.

3. Crux of cost

At the rate of Rs. 10,000 per acre of land as land-cost, and Rs. 40,000 per acre for the provision of such services as drainage, water-supply, electricity and roads, the total cost of development per acre will be Rs. 50,000. It works to about Rs. 500 per *cent* of land developed. But distribution cannot be at this rate as one-third of every acre will be covered by roads and amenities and only the balance of two-thirds will be available for distribution to the people in the form of building sites. So the average price per *cent* has to cover this one-third also. If the average price per *cent* is fixed at Rs. 700, it will solve this difficulty.

The development cost envisaged in this scheme is not high. In 1963-64 the cost of a developed plot per *ground* for the Madras State Housing Board came to about Rs. 4,000. As one acre consists of about 18 grounds, the cost of development per acre can be put at Rs. 72,000. Ultimately the cost per *cent* works to Rs. 720. This figure moved up to Rs. 817 in 1964-65. Naturally, it may be drawn as an inference that the cost of development envisaged by the scheme is cheaper than that worked by experience and hence the proposal is not at all fantastic by any means.

4. Madras State

If we propose to develop about 105,000 acres for the Madras State, the total cost as per our scheme will be about Rs. 525 crores. When this is distributed over a period of ten years, it will work out to about Rs. 52 crores per year. Out of the cost of Rs. 525 crores, the cost of land will cover about Rs. 105 crores. The amount of money spent on development will be Rs. 420 crores. As the money required for development will be collected from the people through the sale of developed plots, the scheme will pave the way for the withdrawal of as much as Rs. 42 crores of money per year from the people of this State alone. To this extent, a considerable amount of money, which would have been in circulation in the economy, will be withdrawn and consequently may have a deflationary effect.

The details of distribution of acreage and cost between the different areas in the Madras State can be as given below in the table.

Zone	Population	Acreage	Cost in crores of rupees
Madras	1,729,151	50,000	250
Madurai	424,810	10,000	50
Coimbatore and Kurichi	405,685	10,000	50
Trichy	249,862	5,000	25
Salem	249,145	5,000	25
Palamcottah	190,048	5,000	25
Vellore	122,761	5,000	25
Tuticorin	127,356	5,000	25
Tanjore	111,099	5,000	25
Nagercoil	106,207	5,000	25
Total	—	105,000	525

Here it may be asked whether this scheme of Rs. 52 crores per year is very high. The answer is to be found in the present capital outlay on these items by this State. On the average, the expenditure on these items comes to about Rs. 32 crores per year for the Madras State. Taking the future needs of a growing population and a rapidly developing economy, the scheme of Rs. 52 crores is not at all high.

If adopted on an all-India basis a total of 1,352,000 acres in 251 urban centres can be developed at a cost of about Rs. 6,760 crores distribubted over a period of ten years. On an average the cost per year will be about Rs. 676 crores. When implemented, at least, as much as Rs. 5,408 crores (*i.e.*, 6760—1352) will be drawn from the people and consumer goods in the form of dwelling house-sites will be created.

The greatest merit of the scheme lies in the fact that it will avoid the chances of unearned income to accumulate in the hands of the people. These incomes, secured through speculative activity on urban-land-sale, will normally produce an inflationary effect. A scheme of this type is on any day better than such inhibitive measures as high taxation, drive against profit-making, etc. Apart from this, the scheme is in perfect conformity with our ideal of 'socialistic pattern'. Over-taxation will affect capital formation. Drive against profit will dampen the incentive for production. What is now required is an attempt to bridge the gap between money and goods. Monetary measures must be supported by incentives for increased production. The scheme will have the double effect of reducing money supply, and increasing goods supply in the form of houses. The earlier we adopt such measures, the better it is for the economy and the nation.

ECONOMY IN STEEL—HOW TO ACHIEVE IT

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> *'Steel is the linch-pin of developments, and all that can be done to save this material, must be done'*
>
> —*Asoka Mehta*

Preface

This is a review of the problem which is currently facing the country and which has been dealt with from time to time by various committees. The intention is to focus the attention again on the subject, to bring the recommendations of these committees together for easy reference, and to suggest a few other ways and means. It is hoped that the suggestions will be found useful. What, however, is most important is an all-out and sustained drive to introduce the measures necessary to have steel

Section 1—the desideratum

In any developing country, the demand of raw materials for industry and construction generally outstrips the production, and this has to be made good by importation, utilizing the foreign exchange. In India, on account of the progressively ambitious Plans and difficult foreign exchange position, this imbalance between demand and production has become all the more critical. Under such conditions, the economical use of building materials cannot be over-emphasized, and out of all the building materials which engineers use, the single item which draws our immediate attention is Steel. It is, therefore, very necessary that utmost economy in steel with adequate safety and efficiency is aimed at by every engineer. Unfortunately, instances are not lacking where enough prudence and investigation have not been exercized which has resulted in avoidable waste.

A study of the anticipated production of rolled mild steel from existing plants in this country after implementation of the present expansion schemes, was made by the National Council of Applied Economic Research (N.C.A.E.R.), New Delhi. The results, given in Tables 1 and 2, will indicate the seriousness of the present situation. The deficit the country will have to face, will be about 100% of the country's production of steel.

In another study conducted by the N.C.A.E.R. to determine the saving in steel that can be achieved by implementing certain measures, which will be discussed later, it is stated that the anticipated production and saving in structural steel during the Fourth Plan period can be 7.6 and 1.79 million tonnes respectively. If this can be achieved, it will mean a saving of approximately 125.3 crores of rupees. What, however, is more concerning is that the only means to meet the deficit in steel is to import at the cost of our foreign exchange, of which the position is very unsatisfactory.

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Table 1

Anticipated production of rolled mild steel from existing steel plants after implementation of present expansion schemes (1,000 tonnes)

Item	Total output from all producers	Demand in 1970-71	Deficit
Semis	153.00	1,418.06	1,265.06
Structurals	1,056.00	1,631.00	575.04
Rails and fishplates	718.00	791.00	73.03
Sleepers	75.00	89.01	14.01
Wheels, tyres and axles	121.00	167.50	46.50
Bars and rods	2,128.00	2,960.00	832.00
Wire rods	—	—	—
Wire and wire products	390.00	790.40	400.40
Plates	370.00	1,747.00	1,377.00
Sheets	1,020.00	2,385.00	—
Strips	—	409.75	1,775.15
Tin plates	330.00	524.40	194.40
Skelp	500.00	679.25	179.25
Total rolled mild steel	6,861.00	13,594.10	6,739.01

Note: The data have been taken from Table 15 in the 'Appraisal of Steel Demand', published by the National Council of Applied Economic Research, September 1963, pp. 166-167.

Table 2

Import of rolled mild steel

Year	Ingots, blooms, slabs, billets	Joists, girders, angles, etc.	Universals, plates and steels	Railway rails
1951	1,702	1,705	2,698	321
1955	5,164	18,158	20,939	8,976
1956	13,687	57,982	33,122	9,920
1957	19,962	45,348	24,202	15,109
1958	16,797	17,844	12,492	16,346
1959	9,649	14,409	21,190	11,005
1960	2,805	13,875	30,753	9,034
1961	1,646	13,092	29,664	14,764
1962	664	8,979	17,291	9,323
1963	8,224	13,196	31,119	—
1964	5,040	17,970	31,697	502

Note: The data have been taken from 'Monthly Abstract of Statistics', August 1965.

Even in countries, which may be considered to have developed industrially, the consumption for steel is progressively increasing. Obviously the proportionate demand in a developing country like India will be much more An appraisal of the annual demand for steel in various countries for the period 1972-75 as compared to that in 1957 was conducted by the United Nations from which it is seen that the consumption of steel in India is likely to increase to 674% above its level in 1957, which is the highest in the world. For comparison, the cumulative figures for the different continents are given in Table 3.

Table 3

Comparative data of steel consumption

(Figures in 1,000 tons)

Country	1957	1972-75	Percentage increase
North America	103.867	157.8	52
Latin America	8.165	22.3	173
Western Europe	75.798	151.5	92
Eastern Europe	67.011	150.8	124
Africa	3.87	9.0	133
Middle East	1.647	5.2	216
China	10.000	53.0	430
India	3.819	28.0	674
Far East	20.046	73.3	266
Oceana	3.511	7.8	122

Note: The data have been taken from Appendix 2 of 'Reappraisal of Steel Demand', published by the National Council of Applied Economic Research, 1965.

That steel has to be saved was recognized in this country nearly two decades ago, i.e., before the inception of the First Plan, and the Government through various agencies like the Institution of Engineers (India), the Indian Standards Institution, the Planning Commission, and the National Buildings Organization, had repeatedly pointed this out. The matter was first mooted out by the Directorate General of Industry and Supply, when they requested the Institution of Engineers (India) to appoint a Committee to go into the question of steel saving in India. The principal recommendations of this Committee are given in Appendix 1. This was followed by the Steel Economy Programme of the Indian Standards Institution, resulting in the Indian Standards relating to production and use of structural steel. The new Indian Standard structural steel sections have now replaced the old British Standard sections and are more economical. Certain initial difficulties in rolling the thin sections are being experienced and some relaxation in web thicknesses had to be allowed. It is hoped that these will be overcome in near future. Subsequently, the National Buildings Organization had also taken up the matter and published the Report of the Committee appointed to investigate into it. The observations and recommendations of the Committee are given in Appendix 2. The measures outlined in the latest report by the N.C.A.E.R., 'Saving in Structural Steel through Standardization' comprise the use of:

- (i) Indian Standard structural steel sections;
- (ii) Welding in fabrication;
- (iii) Tubular structures; and
- (iv) Cold formed light gauge sections.

The detailed recommendations of the Committee are given in Appendix 3. To the structural engineer and the fabricator, however, the report only touches the fringe of the problem because there are many more methods by which economy in steel can be effected. The statistical figures given in the report, however, are very illuminating and should draw considerable attention. According to this report, if the methods outlined therein are followed, there may be an anticipated saving of 23.6% in the Fourth Plan period. For the other Plan periods, the anticipated savings have been estimated as given in Table 4.

Table 4

Anticipated saving in Plan periods

Description	Third Plan	Fourth Plan	Fifth Plan
Anticipated production of fabricated steel structures, 1,000 tons	3,900.0	7,600.0	12,600.0
Saving, 1,000 tons	920.0	1,790.0	2,970.0
Saving, crores of Rs	64.4	125.3	207.9

The figures given above are re-assuring but whether this can be achieved solely by adopting the methods outlined in the report is controversial. For one thing, the portion of saving attributed to the use of Indian Standard structural sections has been liquidated because these are the sections which are currently available and any saving as compared with the requirements if the old British Standard structural steel sections are used, is illusory. The economy in steel can, however, be achieved by the other three methods cited above, but these are closely linked with the comparative costs of the conventional structures made of riveted structural steel and the other three types, *viz.*, the welded structure, the tubular structure, and the use of cold formed light gauge sections.

It must be admitted that the invidual user is ultimately interested in the overall economy and to some extent on expeditious completion of the work, and not so much in the saving of steel. But if the price difference, availability of material, or the expeditious completion of the work attracts him, he will be prepared to accept the other designs which go to save steel. In this respect the designer is at the vantage position from where he can have an objective look on the economical and other aspects, and design his structure to suit either for saving in steel or for saving in overall cost. He has, however, often to sacrifice one, or the other, or both, depending upon circumstances. But what is needed is a combination of both, *i.e.*, saving in steel without sacrificing economy; and in this lies his skill and ingenuity. In a country where there is scarcity of steel, the designer has to depend largely upon the producers for the available structural steel and upon the fabricators on capacity, workmanship and cost of fabrication. The producers of steel and the fabricators can, therefore, help to a large extent. But their problems involve complex techno-economic considerations, including the question of demand and supply, and keeping these in view a realistic planning at all levels is necessary. The Government is aware of it and is trying to solve these through the Ministries of 'Industry and Supply', and 'Steel and Mines'.

It is difficult to say what has so far been deliberately achieved as a result of these efforts but there is no doubt that there is enough scope for economizing in the use of steel. A concerted and sustained drive is necessary in which the user, the designer, the fabricator and the steel producer each must understand and appreciate the difficulties of others. Already a significant step has been taken by the Government in bringing them together at a common table under the auspices of the Joint Plant Committee so that a coordinated plan for economizing in steel can be prepared and launched.

It is suggested that the plan may include formation of an organisation with zonal jurisdictions to undertake the programme given below.

(i) An assessment of the requirement of steel, work-wise.

(ii) A study of the major fabricated steelwork constructions and suggest ways and means to save steel. For this purpose it may obtain help from organizations like the Central Structural Research Institute, Roorkee; the Central Mechanical Engineering Research Institute, Durgapur; or the Research, Designs and Standards Organizations, Ministry of Railways, Lucknow.

(iii) Publish and periodically circulate brochures explaining new concepts in design and new methods of construction which go to save steel.

(iv) Encourage production and use of substitute materials which can replace, or help, to save steel.

(v) Bring to the notice of the Ministry of Industry and Supply, Government of India, the practical difficulties in implementing the measures recommended by the various committees, and see that they are removed as expeditiously as possible.

Section 2—Ways and means

Structural steel is used by engineers for a variety of structures, from the small workshop shed to the large bridge, from the railway carriages and wagons to the rails to run them on. The ways and means of economising in steel are, therefore, many and much depends upon the ingenuity of the engineer. Engineers must realise that economy in steel can be achieved not merely by accurate designing and use of modern principles, but by various other means all of which should be strenuously exploited. He has, however, to condition his design to suit circumstances, such as,

(i) Availability and comparative cost of alternative material,
(ii) Time and facilities available,
(iii) Comparative costs of completed work, and
(iv) Acceptability of unorthodox designs.

In spite of these limitations, however, the structural engineer can play an important part in the effort to save steel. To deal with this problem two ways are open to him, *viz.*,

(a) By using alternative material, and
(b) By economising in steel through his design.

Though a very effective means of saving steel is the use of alternative material, in this review only such of the methods for economising in steel as can be applied without using alternative material will be dealt with. Mention may, however, be made of the use of such alternative materials which go to reduce the dead load of the structure; for instance, light weight aggregates, hollow concrete blocks, aerated concrete for light weight partitions, hollow-tile floors, etc. By themselves, some of these materials appear expensive, but when judged against the saving in steel and the overall cost of a structure, their use can often be justified.

The design of a structure depends primarily on the duty it has to perform, the loads it has to sustain and the stresses to which its parts can be subjected. These are specified in the respective standard specifications and it is, therefore, important that great care is exercised in framing them. Most of these specifications are quite comprehensive but the engineer has to, and must, use his discretion in interpreting the provisions therein.

In this context mention may be made of the floor loads and wind loads acting on a building. The floor loads for the different duties a structure has to perform has been more or less standardised and there are only minor differences between the standards adopted in different countries. The specifications give the minimum loads for design purposes and, therefore, leaves very little choice with the designer. But often at the design stage of, say, a large office building, the service loads for different portions of the building are not definitely known resulting in higher values being generally adopted; thus erring on the side of safety and extravagance. As it is neither possible, nor desirable to design every floor of an office for the maximum possible loadings, it will be better to nominate the floors for specific purposes and impose certain restrictions on loading instead.

In the case of wind loads, however, the standards adopted differ so vastly that great care and judgement is required in assuming the correct figures. In this country the basic wind pressure on structures are given in I.S. 875: Loading Standards. This specification was revised in 1964 and a comparison of the values as per 1957 and 1964 editions is shown in Fig 1

NOTE: CURVE (3) INCLUDES WINDS OF SHORT DURATION AND (2) EXCLUDES THE SAME.

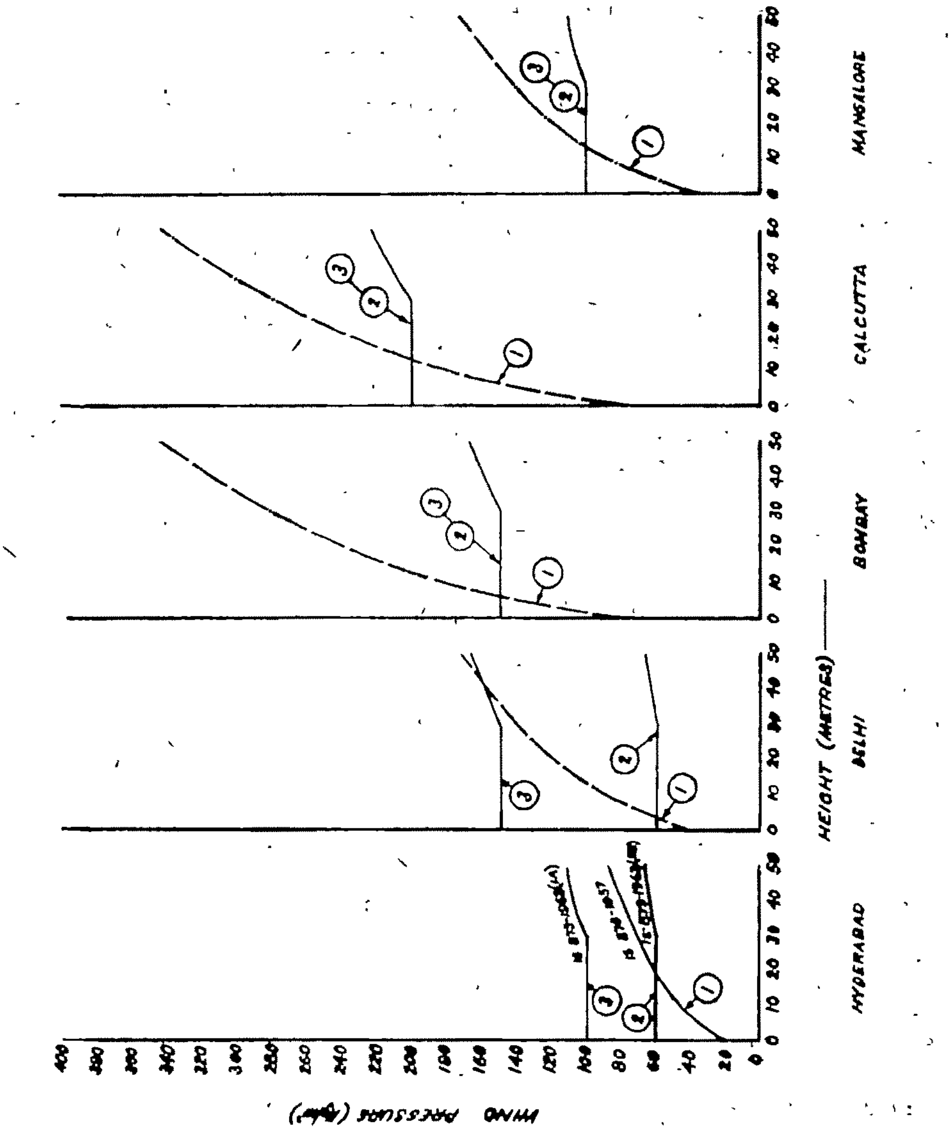

Fig. 1

Comparative values of wind pressures according to old and revised I. S. Specifications

From the graphs it will be seen that whereas there is some relief in the design of tall building frames and in coastal areas, the wind loads for buildings of small heights and in the inland areas, have been increased disproportionately.

For single-storey sheds, as for workshops, in the design of which wind loads have a profound effect, such an increase will result in an increase in steel consumption. The recent revision has been based merely on meteorological data, disregarding the probability factor and the statistical data on the effect of wind on buildings, its cladding, etc., which, though designed for lesser wind loads, have withstood equally severe squalls in the past It is, therefore, questionable if such an increase is warranted.

A comparison of the wind pressures according to different specifications will immediately indicate the severity of the provisions in the I.S.I. Specifications. It will interest the reader to know that the pressures adopted in some of the buildings are very much lower than what can be estimated according to I.S.I. Specification. For instance, the wind pressures adopted in the design of 'Shell Centre' in London, which is 350 ft. high is only 25 lb. per sq. ft. In the case of Millbank Tower, the velocity was assumed to be 75 miles per hr. and for the nearby Hide Tower, 230 ft. high, the basic design pressure was only 17 lb. per sq. ft. There is, therefore, a strong case of revising the wind loads and bringing them down to a reasonable practical figure and the sooner the I.S.I. does it the better it will be in the matter of steel economy.

According to the I.S. specification a structure has to be designed for the worst combination of loads. The probability of such a combination occurring in the life of a structure and the risk involved in case of failure is not generally considered by the engineer. The probability aspect in civil engineering design has lately drawn the attention of engineers both in the U.K. and the U.S.A. and a statistical approach to the design has been advocated by many. The recommendations of the *ad hoc* Committee appointed by the Institution of Structural Engineers, London, to examine this aspect are reproduced below.

"*Practical recommendations*

As a result of the deliberations of the Committee, in addition to and growing out of the foregoing paragraphs of this report, it is desired to draw attention, and in particular the attention of Codes of Practice committees, to the following recommendations affecting current practice:

(a) *Load and material data*

Codes of Practice should be drafted to envisage and encourage an increasing use of the realistic statistical approach, conceding benefits to practices leading to improved knowledge of loads and of material properties.

(b) *Test data*

Codes of Practice should be drafted to encourage the use of model and full scale structural tests to improve knowledge of the behaviour of the structure concerned, and to allow, with suitable safeguards, of appeal to relevant test data in the absence of, or to supplement, suitable design calculations.

(c) *Ultimate loads*

Codes of Practice should be drafted to encourage the use of calculations and tests directed to the prediction of collapse loads, supplemented by calculations and tests aiming to ensure satisfactory behaviour at lower (working) loads.

(d) *Limiting conditions*

Endeavours should be made to specify such conditions in increasing detail in relation to each of the commoner classes of structure.

(e) *Design life*

Where practicable, Codes of Practice should give guidance on, and standardise modes of specifying, the life to be expected of the commoner types of structure.

(f) *Ultimate load factors*

Ultimate load factors should be decided upon having regard to the probability of collapse, but provision should be made for some variation of ultimate factors according to the seriousness of the practical effects of collapse in any given case.

(g) *Further research*

More research in this field is obviously needed and, in particular, the committee recommends work on:

(i) Loading statistics,

(ii) Methods of predicting ultimate strength,

(iii) The specification of limiting conditions, and

(iv) Systems for assessing load factors."

Prof. A. G. Pugsley has aptly summarised the work of the Committee as follows:

(i) Since the war in particular, structural engineers have become far more interested than hitherto in the means of specifying safety measures,

(ii) There has been a growing interest in the prediction and use of ultimate load in relation to safety measures, and

(iii) There is a greater interest in the statistics of accident risk and the use of the probability theory in the discussion of some of our safety problems.

This aspect of structural design was also considered by the Committee on Factors of Safety appointed by the American Society of Civil Engineers and has created interest in many engineers, notable among them being A. M. Frendenthal and Oliver G. Julian. The Committee has also drawn the attention to the work done by the British Committee and the 'Report on Structural Safety' published in *The Structural Engineer,* May 1955. An extensive bibliography on this subject is given in 'Safety and Probability of

Structural Failures' by A. M. Frendenthal, published in the *Transactions of the American Society of Civil Engineers*, vol. 121, 1956.

That there can be economy in design by applying the probability factor, *i.e.*, having a statistical approach to the design problem, has been amply illustrated by many engineers The old methods of applying the 'thumb rules' or empirical factors are gradually giving place to more exact determination of forces and effects, all tending to more economic designs. Even the impact and fatigue factors for bridges have been subjected to statistical scrutiny and the views have undergone a change. A statistical study of the impact stresses under different types of traffic in the British Railways has recently been concluded, and it is seen that for bridges tested there is less than one chance in a thousand of a stress greater than 1.3 times the design value being exceeded during the passage of normal rail traffic. However, to make allowance for smaller probabilities of occurrance in the case of rail-bearers, where the number of stress cycles experienced in the passage of a train is greater than any other member, this factor has been increased to 1.5. Comparatively, the impact factor deduced by a semi-empirical formula always gives higher values. Unfortunately, not much thought has so far been given in this country to this line of approach and it is high time that it is seriously taken up.

Some agencies, especially the government departments, regard the codes and specifications as mandatory and even in marginal cases, the designer especially in the public sector hardly exercises any discretionary powers. Just as in the specifications of the materials used in construction (certain tolerances are allowed in designing also), the engineer should apply certain discretionary powers in marginal cases. It is, therefore, necessary that a realistic approach be made both while framing the specifications and while applying them; but a warning must be sounded that it will be dangerous to apply relaxations in design unless the engineer is guided by a good experience and can justify a certain amount of calculated risk taking into consideration the actual conditions, the most important of which are the qualities of material and workmanship and the probability factor. In this connection, Prof. Frendenthal of Columbia University, one of the advocates of the probability theory, has aptly warned that 'probability theory and statistical methods based thereupon, while extremely valuable tools in design, can be effectively used only in conjunction with a thorough knowledge of the operating conditions of the structures and its structural action, and with sound engineering judgement'.

It has been pointed out above that the choice of a designer is often limited by the material available, which in structural steelwork is rolled steel products. That there is scope for economising in the structural steel sections was the first step rightly taken by the Indian Standards Institution in their Steel Economy Programme. An assessment of the economy that can be achieved by using the Indian Standard structural steel sections has been made by the N.C.A.E.R. in the report of the Committee on 'Saving in Structural Steel through Standardisation'. The table below reproduced from the report of N.C.A.E.R. shows the saving that can be effected by using comparable old F.P.S. and the new metric I.S. section of beams.

Table 5

Data of saving in steel

Inch sections			Equivalent Indian Standard sections			Saving, %
Size, in.	Z_{xx} cm.^{3}	W, kg. per m.	Size, mm.	Z_{xx} cm.^{3}	W, kg. per m.	
4×1¾	29.99	7.44	150×50	42.9	7.1	4.6
4×3	63.75	14.88	200×60	78.1	9.9	33.5
4¾×1¾	46.38	9.67	175×80	54.8	8.1	16.2
5×3	89.64	16.37	225×80	116.3	12.8	21.8
5×4½	164.06	29.76	200×100	169.7	19.8	33.5
6×3	114.71	17.86	225×80	116.3	12.8	28.3
6×5	238.60	37.20	250×125	297.4	27.9	25.0
7×4	185.01	23.81	225×100	222.4	23.5	1.3
8×4	227.94	26.79	250×125	297.4	27.9	—4.1
8×5	367.40	41.67	275×140	392.4	33.0	20.8
8×6	471.29	52.09	300×150	488.9	37.7	27.6
9×4	295.46	37.20	250×125	297.4	27.9	10.7
10×4½	400.99	31.25	250×125	410.5	37.3	—0.3
10×5	479.32	44.64	300×150	488.9	37.7	15.6
10×6	671.22	59.53	350×165	751.9	49.5	16.8
12×5	603,70	47.62	325×165	607.7	43.1	9.5
12×6×0.40*a*	1,026.32	80.35	450×170	1,223.8	65.3	18.7
12×6×0.50*a*	865.08	65.47	450×165	9,65.3	56.9	13.1
14×6×0.40*a*	1,035.99	68.45	450×170	1,223.8	65.3	4.7
14×6×0.50*a*	1,248.53	84.82	450×150	1,350.7	72.4	14.6
15×5	936.20	62.50	400×165	965.3	56.9	9.0
15×6	1,074.83	66.97.	450×170	1,223.8	65.3	2.5
16×6×0.40*a*	1,266.07	74.41	450×150	1,350.7	72.4	2.7
16×6×0.55*a*	1,485.16	92.26	500×180	1,543.2	75.0	18.7
18×6	1,532.69	81.85	500×180	1,543.2	75.0	8.4
20×6½	2,009.39	96.73	500×250	2,091.6	95.2	1.6
22×7	2,498.05	111.61	550×250	2,723.9	112.5	—0.8
24×7½	3,459.15	139.89	600×250	3,540.0	133.7	4.4

Average saving . . 12.8%

Note: The third factor '*a*' in the first column refers to web thickness.

Unfortunately not all this economy is possible because the designer has to choose from the list of rationalised steel sections which introduces serious limitations. The list of rationalised steel sections was published by the Iron and Steel Ministry in consultation with the producers and users of steel to reduce the number of different sections or sizes which the producers are called upon to roll. This increased the availability of matching steel sections, but limited the scope of the designer. For instance, out of the 23 sections shown in the Table above, only two sections, the use of which can only give savings of 2.1% and 8.8%, have been rationalised, whereas the sections which give economy of over 20% have not been rationalised. The reason given is that the demand for other sections is not large enough to attract the producers. On the other hand, with the limited list of rationalised sections with him the designer has a limited choice. This conflicting situation needs careful consideration and the sooner the list of rationalised sections is expanded, the easier it would be for the designer to economise in steel. It has, however, other co-existing problems, like cost of production for small-demands, increased outlay, etc., on which decisions are not easy to make. The designer has, therefore, to overcome this by other means, some of which have been suggested in the report of N.C.A.E.R mentioned above These are as follows:

(a) *Adoption of welding*

That welded structures consume less steel than riveted ones has been clearly established. It must, however, be realised that welding is not a substitute for riveting and to achieve economy a different approach to design and fabrication is necessary. Welding is an expensive process and unless care is taken the finished cost of a welded structure may be more than that of a riveted one. To make welding more popular and economical and to produce better welds, it is considered necessary that automatic welding plants and equipments for testing welds are made easily available. The equipment to test welds by gamma-rays is now available with the Atomic Energy Commission (Isotope Division) and progressive use of this should be made. Testing fillet welds by this method is difficult and is, therefore, not generally done. For fillet welds, other physical tests are necessary. As far as manual welding is concerned, more extensive facilities for testing welders and issuing proficiency certificates are necessary.

(b) *Use of bar joists*

For structural members carrying light loads over long spans, such as purlins in which the shear loads are small, nothing is more economical than the use of bar joists. These consist of tension and compression flanges connected together by a web system consisting of round bars or flats welded to them. The Central Mechanical Engineering Research Institute, Durgapur, has developed the design of a portal frame structure in this type of construction. The weight per sq.m. of covered area for a 52 ft. span portal frame is 6 lb. per sq. ft.

The most extensive use of this method of construction has been is in the Indian Railway Standard platform roofs, which give a weight of 20.5 kg. per sq.m., or 4.2 lb. per sq.ft. for a purlin span of 50 ft. with the column and cantilevers, the weight is about 6.5 lb. per sq.ft. (Fig. 2)

These are simple to fabricate, the welding involved is small and even with the special jigs required for fabrication, they work out economical. The cost of the bar joists designed by C.M.E.R.I. work out to Rs. 1,450 per tonne, including the design charges of Rs 50 per tonne. The ones made by the railways cost Rs. 1,200 per tonne.

(c) *Tubular structure*

Though tubular structures lead to considerable economy in steel, their use is limited by factors like availability and cost. Unless the cost can be comparable to ordinary structural steel and their availability becomes easier,

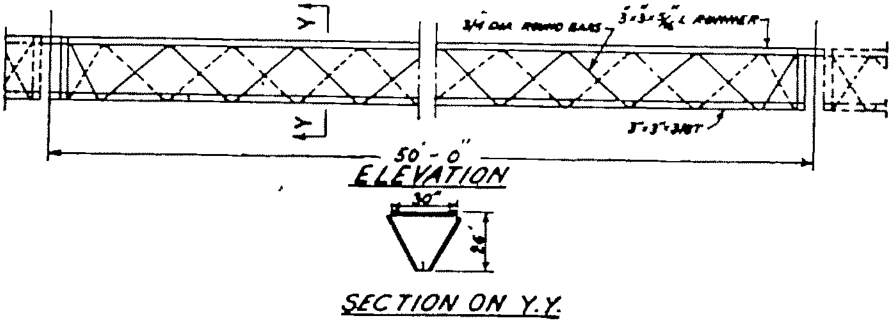

Fig. 2

Indian Railways standard purlin

the user will not be much interested The cost of tubular structures at present is about Rs. 2,000 per ton for purlins and Rs. 2,300 per ton for trusses. The weight of tubular sheds including columns is, approximately, 15 kg. per sq.m. or 3 lb. per sq.ft. According to IS : 806-1956, Code of Practice for Use of Steel Tubes in General Building Construction, the tubes used in structures are to I.S. specification no. 1161. To encourage the use of tubular structures, the I.S.I. may also include the use of tubes to the alternative specification I.S. 1239-1964. The I.S. specification at present stipulates the minimum tube thickness at 10 gauge. Experience with 12 gauge thickness, however, has shown that they have stood the test of time. It is, therefore, desirable that the minimum thickness be altered to 12 gauge. Though tubular structures are extremely light and help in steel economy, they are rather expensive. It is also suggested that to make them corrosion resistant, copper bearing steel be used in such tubes

(d) *Cold-formed light gauge sections*

Though this material contributes to the maximum saving in steel, it has two disadvantages, *viz.*, lack of corrosion resistance and availability. Unless adequate facilities for maintenance are available, the use of cold-formed light gauge sections should be limited to non-corrosive areas and copper bearing steel be used. The cold-formed light gauge sections are covered by Indian Standard Specification No. 811, and are manufactured in the country. It is also necessary that trials be conducted to determine its life in coastal and inland areas. Production of the material is limited and the use is further limited due to lack of knowledge. It is, therefore, necessary that enough publicity is given to this material. Unless a demand is created, the producers will have no incentive.

Besides the four methods of conserving steel, mentioned above, the structural engineer knows that many more methods can be devised to achieve economy in steel. Some of these are mentioned below :

(i) *Welded beams*

It has been pointed out above that the choice of a design is limited to the rationalised steel sections available and he has, therefore, often to choose a section which is heavier than what is needed. To get over this, the designer may find it more convenient to use beams made up by welding plates, but the use of fillet welds make the work difficult to execute and expensive. Recently the use of electric resistance welding in producing such beams has been commercially successful. The economics of these, however, have not yet been worked out and published in this country. It is necessary that trials be conducted to find the practicability of this method of producing structural steel sections like beams, channels, box sections, etc. Once the economy of using such sections can be established, the user will find such sections more convenient but the incentive to use such sections must originate at the producers level by suitable publicity and attracting the user by offering suitable alternative welded sections against the demand for rolled steel products.

(ii) *Castellated beams*

A more expedient method to give a large choice of steel sections to the designers is to slit a beam along its length, and separate the two parts by welding a plate or laced flats. Alternatively, the beams may be cut and reformed as 'castellated beams'. These are shown in Fig. 3.

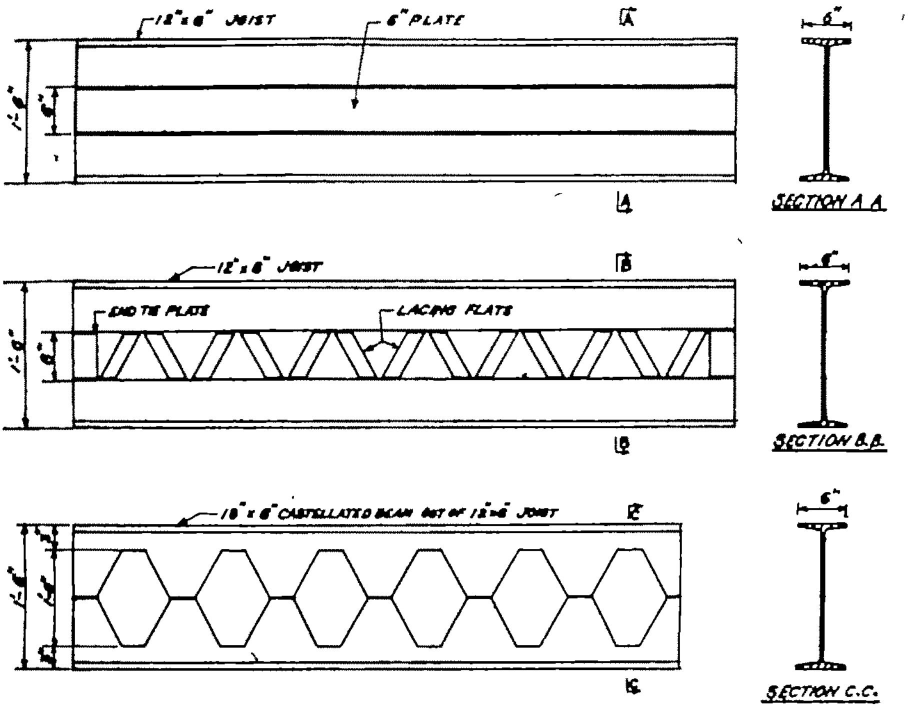

Fig. 3

Welded sections

The castellated beams are produced by flame cutting the web of a joist staggering the two pieces and welding the web at the joints by electric arc or electric resistance welding. The economy in steel that can be achieved can be judged from the figures in the table below obtained from the old British Sections

Table 6

Economy in steel with castellated sections

Original, in.	Castellated, in.	Z, in³	Weight, lb. per ft.	Difference, lb. per ft	% saving in weight
6×3	9×3	11.0	12	4	25
7×4		11.29	16		
12×6	18×6	99.3	54	16	23
14×8		100.8	70		
15×6	22½×6	131.3	45	30	40
18×7		127.9	75		
18×8	27×8	224.8	80	15	16
24×7½		211.09	25		

Though there is an appreciable in weight, some of it will be offset against the cost of gas cutting, welding and wastage. The cost of production of a 20 ft. long castellated beam, out of 12 in.×6 in. section, can be estimated as follows :

Length of beam	8,000 mm	
Weight of beam	0.64 tonne	
Cost of beam at Rs. 750 per tonne		Rs. 480
Length of cut	10,450 mm	
Cost of cut at Rs. 3 per m.		Rs 3.15
Length of weld	1,770 m	
Cost of weld at Rs. 1.5 per m.		Rs. 2.65
		Rs 485.80
Weight of equivalent joist	0.84 tonne	
Cost	Rs 622.50	

It is therefore suggested that the production of castellated beams be taken up by the industry. The centralised production will bring down the cost and assure availability at all times. To encourage its use, alternative castellated beam sections should be offered by the trade to the indentors. The properties of castellated beams for the I.S.I. sections should be worked out and circulated by I.S.I. for general information

(ii) *Twisted bars as reinforcements*

The use of twisted bars according to I.S. as reinforcements has been included in I.S. 456: Specification for Plain and Reinforced Concrete for General Building Construction. The use of these bars is of a recent origin and in the earlier stages it was considered that during twisting the bars should not be allowed to shorten, for which heavy anchorages were required. Subsequent tests have shown that this is not necessary and twisting alone is sufficient which made the process much easier. All that is necessary are two lathe chucks, one at either end of a bed. The bars can be single or twin twisted in accordance with the provisions given in the I.S. specification.

The mechanical properties of the twisted bars as compared to the ordinary bars are as given in the table below.

Table 7

Mechanical properties of twisted and plain bars

	Twisted or deformed bars	Plain bars
Ultimate tensile stress, kg. per mm.^{2}	49.5	42
Permissible stress, kg. per mm^2	19.0	14.0
Elongation, %	12	20

During twisting the bars get cold worked and strain hardened, the mechanics of which may be seen in any standard reference. The loss in elongation percentage was, however, a matter of concern to engineers but it is seen that further cold working of the bars to form hooks with internal diameter equal to 2.5 times the diameter is possible. No welding, however, should be done after the bars have been twisted. Therefore, if such bars have to be joined by welding instead of lapping, they should be welded before twisting. A practical advantage in twisting the bars especially when using untested bars is that each bar automatically gets tested. Tests conducted have indicated that the bond strength of twisted bars had increased to 1,354 lb. per sq. in. as against 700 lb. per sq. in. for ordinary bars. The I.S. specification does not allow any increased compressive stress in the twisted bars and they cannot be used with advantage in columns. Tests conducted in the United Kingdom have, however, shown that even in columns twisted steel is more efficient as it develops a strength up to 55,000 lb. per sq. in. as against the yield strength of 36,000 lb. per sq. in. for mild steel. Twisted steel is therefore 50% more efficient in compression. In these respects, further investigations and a revision of the I.S. specification will be desirable.

The economy in using twisted bars need not be dilated upon but it must be emphasised that a higher grade of concrete, say, with a permissible stress of 1,000 lb. per sq. in. (which is not difficult to obtain) gives better results. The cost of twisting the bars works out to approximately Rs. 100 per ton. In this country twisted bars were probably most extensively used for the first time in the precast concrete roof trusses for the Furnishing Annexe to the

Integral Coach Factory, Indian Railways, Madras. A few interesting figures for this work are:

Covered accommodation	350,000 sq. ft. (32,530 sq. m.)
Cost	Rs. 32 lakhs
Bars used	
Untwisted	870
Single twisted	230
Total	1,100 tonne.

Had only ordinary mild steel bars been used, it would have required 1,535 tonnes, *i.e.*, a saving of 28% was achieved. A steel truss design would have taken 2,250 tons of steel.

These bars are also being used in the construction of the headquarters offices of the newly formed South Central Zone at Secunderabad. A rough estimate has shown that the saving achieved by using twisted bars instead of plain bars is to the extent of about 30%.

One of the objections in using twisted bars is that when subjected to high stresses, they are likely to develop cracks in concrete which ultimately may induce corrosion, especially in coastal areas. Use of high tensile and even medium tensile bars may also cause such cracks. Researches have, however, shown that cracks of 0.01 in. (0.25 mm.) occur when the stress in steel is 50% above the permissible. Normally the stresses occurring are less than the permissible and hence the formation of cracks need not be viewed with concern.

The impediment in the use of twisted bars, to some extent, is the additional effort required in producing the bars at and for every work. It is, therefore, suggested that the production and marketing of twisted bars be organised on a commercial basis and offered to the indentors as alternative material.

Saving in steel used as reinforcement is also possible by using deformed bars which have been standardised under Indian Standards Specification no. 1139. The permissible stresses for deformed bars are the same as for twisted bars. A note on the use of deformed bars appears as Technical Information Series no. 4 issued by the National Buildings Organisation, and also appended to the report of the Committee on 'Economy in Steel'. The availability of deformed bars is, however, limited in the country and needs encouragement from the producers as well as users.

(iii) *Composite construction*

The use of concrete and steel together, such that concrete takes the compression and steel the tension, is made in all normal reinforced concrete. In this the steel generally takes the form of round or square bars wholly embedded in concrete and the stresses are transmitted through bond. In composite construction, which is of a more recent origin, the steel of the compression flange of a steel girder is either wholly or partly substituted by concrete.

For the concrete and steel to act as a composite unit, monolithy is achieved by providing what are known as 'shear connectors'. The usual forms of shear connectors used are shown in Fig. 3.

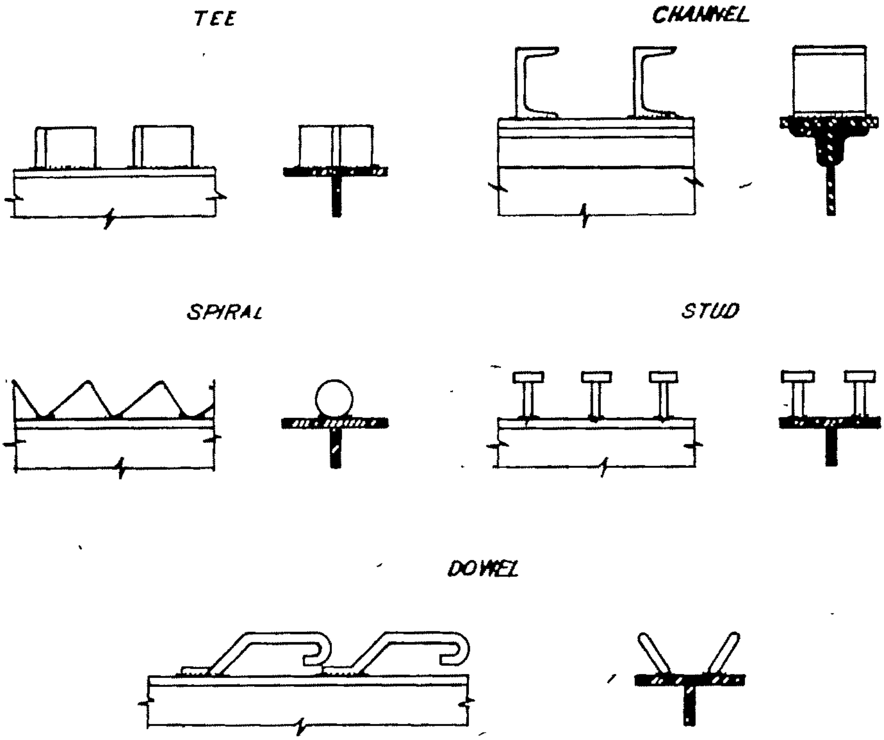

Fig. 4

Common type of shear-connectors

In a steel framed building, the concrete floor slab used to be, and even now is generally designed by many as separate from, and supported on, the steel girders, as distinct from a R.C.C. framed building-where the floor slab forms a T-beam with the floor beams.[4] By using the shear connectors with the steel beams, the same floor slab is used with advantage.

Recent investigations, however have shown that under certain conditions shear connectors need not be provided in the composite beam. The bond between steel and concrete is sufficient to develop the required shear. This has been incorporated in the latest revision to B.S. Code of Practice, C.P. 117, Part I. By combining the steel beam with the concrete floor the neutral axis is shifted towards the compression flange thus increasing the modulus of section of the tension flange. For a full technical appreciation of this form of construction, reference may be made to standard books and Codes of Practice.

The practical difficulty in fabricating these girders is the welding of the shear connectors and good concreting but this should not prevent the structural engineers from using these. The simplest form of shear connector is the stud, but these require special equipment and material. To encourage its use it is suggested that the guns used for welding the stud type shear connectors be made available to fabricators.

The composite girder has been used in bridges also. Important examples are the road decks of the Ganga and Brahmaputra bridges. Recently, it has also been used in a 40-ft. span, broad gauge main line bridge of the railway. Apart from the various advantages offered by a ballasted deck bridge, there is a saving in structural steel of about 13%. To encourage the use of this form of construction, designs of other spans are in hand.

(iv) *High tensile structural steels*

The use of high tensile structural steel (I.S. 961) in this country unfortunately is not yet very popular. Presumably because this material is not as freely available as mild steel, most of the designs are in mild steel. On the other hand, production of small quantities of high tensile steel may not be economically possible. This is a matter which should draw the close attention of the designers and producers of steel. The setting up of a Central Advisory Bureau which will promote the use of these steels, and enough publicity, may help to a large extent. The comparative figures for cost and strength of mild and high tensile steels are given in the table below.

Table 8

Comparative figures for cost and strength of mild and high tensile steels

Particulars	I.S. 226	I.S. 961
Structurals :		
Base price	Rs. 738	Rs. 778
Ultimate stress, kg. per mm.^{2}	42	55
Yield stress, kg. per mm.^{2}	23.6	33.1
Permissible stress, kg. per mm.^{2}	14.1	19.3

Apart from the saving in cost due to increased permissible stresses, they help reduce the dead load of the structure proportionately.

It is not proposed to discuss in detail the use of alternative materials which can be exploited to save steel but that it can be a fruitful source has been accepted. Of the alternative materials, the most common is concrete—plain, reinforced and prestressed. The economics of concrete *vs.* steel is often controversial and is a subject by itself but for multi-storeyed building of up to 6 or 7 floors, say, the concrete frame is more economical. Certain economy which can be achieved by using pre-cast elements is often lost due to lack of suitable equipment and knowledge in the technique of construction. Similarly, the use of prestressed concrete which as yet has limited scope in the country due to shortage of indigenous high tensile alloy steels, need encouragement.

The use of alternative material to reduce the dead load on the structure needs careful consideration. The two substitutes which can be used to replace brick or plain concrete in partitions, etc. are the foam concrete or cinder concrete. The weights and strengths of these are as given in the table below.

Table 9

Foam concrete products

Weight	Strength, lb. per sq. in.	Use
20 lb. per c.ft.	100	Insulation
45 lb. per sq.in.	500	Partition, reinforced walling, and reinforced roofing

Table 10

Cinder concrete

Proportion of cement lime : cinder by volume	Weight, lb. per c.ft.	Average strength at 28 days, lb. per sq. in.	Use
1 : 0.25 : 7	80 to 100	2,500	Combined light weight aggregate (coarse and fine) for concrete
1 : 1.3 : 18		800	
1 : 1.5 : 25		650	
1 : 2 : 40		630	
1 : 2 : 60		630	

The use of light weight substitutes, however, can only be popular when they can be made easily available and their cost is comparable to the brick wall. To set an example to the private sector, the Government should encourage the use of alternative material in the public sector.

The review of the economy in steel will not be complete without a reference to corrosion problems in the country. It has been estimated that corrosion and its prevention costs India about Rs. 150 crores a year. The major share in this is attributed to railways where the malady of corrosion in rails, coaches and wagons, bridges, locomotives, etc., has drawn serious attention. Good work in devising ways and means to prevent corrosion is being done in the Electrochemical Research Institute, Karaikudi, South

India, and the Metallurgical and Chemical wing of Research, Design and Standard, Organisation of the Indian Railways. If a serious thought is given to the maintenance of structures also, considerable amount of steel required for replacement and repairs can be saved.

It has also to be accepted that economy in steel can be achieved by introducing the modern concepts in designs, and it is necessary that a breakthrough from the conventional types of structures and methods of designs is of utmost importance. Any structural designer knows that during the last two or three decades, revolutionary changes have been made in this field. Some of the modern conceptions, for instance, are the plastic theory, the space-frame design, structural prestressing, the use of shear walls in building frames, the shell and folded plate roofs, the geodesic dome, etc. The electronic computer is being progressively used by the structural engineer and the designer is able to analyse the stresses in complicated structures. These new concepts are not merely exercises in structural engineering, and are only accepted if they produce efficient, economical and elegant structures. In the initial stages, an introduction of non-conventional designs need hard work, a conviction of one's own, a certain amount of boldness and persuasion. Without these, progress is not possible. Unfortunately, these new advances in structural engineering are not being exploited as much as the demand for economy in steel requires. To popularise the new ideas, a good deal of publicity will be required and this can be done by the Council of Scientific and Industrial Research through their Central Structural Research Institute and the Central Mechanical Engineering Research Institute. As a large amount of work is handled by consulting engineers, their help in this direction should be enlisted through various associations. With the progress that has been attained elsewhere, there can be no doubt that new designs have been tried in this country also but these have not had sufficient publicity so that engineers in general could benefit therefrom. It is suggested that suitable brochures giving the broad details of the new methods which have been, or can be tried out to effect economy in steel, be published and widely circulated among the design engineers and fabricators. Unless the advantages are brought out forcefully and an interest created in them, the progress will be slow and the desired results will be a long way off.

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Appendix 1

Recommendations of the Committee on Steel Saving, appointed by the Council of the Institution of Engineers (India), May, 1949

The Committee in their report have dealt with the following aspects:

(i) Use of alternative materials,

(ii) Welding,

(iii) Design improvements,

(iv) Use of steels of higher performance, and rationalisation of steel sections, and

(v) Miscellaneous.

The important recommendations of the Committee are given below:

1. The principal and largest items requiring the use of steel in this Country are rails and sleepers. The Committee notes with satisfaction the research and investigations in hand to develop really economical rail sections and a reversal of the tendency to substitute existing rails with heavier rails.

2. The Committee is of the opinion that the re-rolling industry should be expanded and encouraged under proper Government control and supervision, so that all available scrap can be used effectively. The Committee recommends that all scrap arising such as old rails from the railways should be diverted for re-rolling rather than used wastefully for fencings, posts, beams, etc. The Committee recommends the prohibition of the export of scrap.

3 The Committee recommends that a special Committee should be formed with representatives of the Building Research Committee of the Board of Scientific and Industrial Research, the Railways, the Roads Organisation, and the Central Waterpower, Irrigation and Navigation Commission, for developing substitute materials and new methods of design, fabrication and construction.

4. The Committee noted with disfavour the present practice of inviting steel work quotations on the tonnage basis, which gives little or no scope to the designer to produce economical designs. The Committee therefore recommends that wherever possible quotations for steel work should be invited on a lumpsum basis subject to compliance with Standard Specifications and Codes of Practice.

5. The Committee was informed that the present method of making small allocations for a large number of different jobs, led to large quantities of steel lying idle. The Committee, therefore, recommends that more steel for fewer jobs should be allocated in proper sequence, *i.e.* stanchion sections should be supplied first and purlins last.

6. The Committee was informed that official authorities such as the Provincial Controllers, Railways, etc. supplied steel in stock lengths and sizes, rather than in those actually required. This leads to considerable wastage which, in the opinion of the Committee, can be avoided by following the pre-war practice of supplying steel in correct sizes and lengths.

7. The Committee recommends the use of cast iron instead of steel for compression members wherever possible.

8. As regards imports, the Committee recommends that we should, as far as possible, import only those sections which are not made in the Country.

9. As regards steel bars for the reinforcement of concrete, the Committee recommends that deformed bars should be utilised as far as possible in order to increase the permissible bond stress. Indian

steel mills should be encouraged to undertake the manufacture of such bars.

10. The Committee realises that in many cases the use of substitute materials, would increase cost but recommends that cost alone should not be the final criterion. So long as the acute shortage of steel continues, the Committee recommends that substitute materials should be used if it means an increase in cost upto 25%

11. The Committee considers that an improvement can be brought about in the long run only through a healthy and independent profession of Consulting Engineers and recommends that Government and other public bodies should encourage the profession of Indian Consulting Engineers.

The Committee recommended that action be taken on the following:

1. Standardization of hot rolled sections.
2. Standardization of fabricated sections.
3. Preparation and adoption of standard Codes of Practice for the use of structural steel.
4. Standardization of typical structural designs.
5. Implementation of the above revised standards through demonstration and regulations, if necessary.
6. Saving of steel up to 25% may be possible if new standards and codes of practice could be evolved and made available to practising Engineers.
7. The work of standardization and preparation of codes could be undertaken by the Indian Standards Institution by forming expert committees consisting of representatives of technical experts, producers, consumers, etc. and recruiting the necessary staff for making detailed calculations.
8. So as to enable practising Engineers to adopt the new standards and codes of practice, efforts should also be made to standardise typical structural designs normally required.
9. Scientific investigation into factors which would help to reduce the factor of safety should be undertaken both in the laboratories maintained by the industry as well as in research organisations.
10. The new standards and codes of practice should be implemented by suitable demonstrations and regulations, if necessary.
11. Adoption of more scientific design so that one could be more certain of the ultimate structural strength.
12. Improving the method of production and the class of workmanship so that one could be more definite of the qualities of the product produced after fabrication.
13. Closer control of fabrication and construction processes.

Appendix 2

Recommendations of the Committee constituted by the National Buildings Organisation on Economy of Iron and Steel in Building Construction

1. The measures required to ameliorate the existing shortages in iron and steel materials, in so far as the building industry is concerned are partly technical and partly administrative and these should go hand in hand to produce useful results.

   Further, such measures are either long term or immediate, permanent or temporary for the duration of this shortage (which as far as can be envisaged is likely to last for a considerable time). The immediate measures include adoption of higher stresses, more rational use and design of steel structures and use of substitute materials. The long-term measures include imparting training, encouraging better design practices and use of new techniques and materials.

2. The use of structural steel in building construction should be reduced to a minimum by its substitution by reinforced concrete and prestressed concrete and where possible and economical, by timber and aluminium where such substitute materials are available. Further re-inforced or pre-stressed concrete members should be efficiently designed to release maximum quantities of M.S. bars and rods and pre-stressing steel for use as substitute for structural steel.

3. The types of buildings and situations where steel of either category, *viz.* structural or re-inforcing may be used have been indicated in broad terms. These have to be adapted to circumstances obtaining in each region. The important point is that a competent technical authority should consider all these alternatives and adopt the one which is economical and suitable for the particular situation. The measures can be termed mostly administrative and partly technical.

4. Since M.S. rods and bars are the categories to be preferred to structurals from the foregoing considerations, the Ministry of Steel, Fuel and Mines and Iron and Steel Controller should investigate the possibilities of turning out more M.S. rods and bars than at present, sacrificing, if necessary, equivalent quantities in the category of structurals.

5. The need for substituting structural steel and ordinary reinforced concrete by pre-stressed concrete is vital in the present context of shortages of both cement and steel.

   (i) As a positive step towards this end it is necessary to ensure that adequate quantities of pre-stressing steel should be available in the country from which the intending consumers can draw without going through the time consuming procedure of importing their requirements for each individual use as is being done at present.

   (ii) For this purpose it is considered necessary to stock some quantities of this material against anticipated demands.

(iii) The Government may constitute a Committee for the purpose of determining the quantity and specifications of the material to be so stocked. This Committee may include the Consulting Engineer (Roads), the Engineer-in-Chief, Army Headquarters, the Chief Engineer, Central P.W.D., the Ministry of Railways, Railway Board and representatives from State Governments who ordinarily use this material.

(iv) The purchase, stocking and distribution of this material may be handled by the State Trading Corporation, a portion of the foreign exchange at present spent on the purchase of steel from abroad is being diverted for this purpose.

(v) The Committee referred to in para (iv) above will recommend the procedure to be adopted for allocation and distribution of this material to users against approved demands.

(vi) The present practice of permitting import of this material against *ad-hoc* indents should also continue and may even be liberalised to the maximum possible extent.

6. Timber is another substitute material proposed. Roofs of many buildings can be changed to timber construction. There is, however, an acute shortage of structural timber like teak; secondary timber can be used for structural purposes provided they are seasoned and adequately treated. Facilities for such treatment are at present inadequate with the result that this change-over is rendered difficult. Steps should be taken to make available in the market adequate quantities of treated timber of secondary species for structural use. For this purpose a careful study, regionally, of the availability of timber (other than teak) should be made in collaboration with forest departments. If careful planning is done, the Committee feels, the change-over of roofing specifications to timber can be effected in a few years. These measures are technical and administrative.

7 To reduce dead weight in structures and consumption of steel, light weight construction is essential for multi-storeyed buildings. Hollow clay tiles and hollow concrete blocks with light-weight aggregates are suitable for this purpose. The Committee considers that the Government should set up plants immediately for producing these materials in principal areas where multi-storeyed construction is coming into practice.*

These measures are mostly administrative and partly technical If the materials are freely available economically, the technician will adapt his techniques to make use of them.

8. Use of Deformed Reinforcing Bars in Concrete effect considerable economy in M.S. re-inforcement. A note on Use of Deformed Re-

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* The Chief Engineer, Central P.W.D. was of the view that the suitability of hollow clay tiles and concrete blocks with light weight aggregate should be examined further before setting up factories for their manufacture.

inforcing Bars in Concrete' prepared by N.B.O. is given in Technical Information Series, 4.

The Committee is informed that the Tata Iron and Steel Company is in a position to place these bars on the market at a nominal extra cost above the price of M.S. rods and bars. The Committee recommends that this may be done immediately and that these rods may be made available preferentially to M.S. rods and bars. The Government may inform concerned departments and State Governments that this material should be used wherever possible taking advantage of the increased bond. These measures are partly technical but most administrative.

9. The Committee considers that there is room for economy in steel by its more rational use. This is amplified in the recommendations that follow.

10. The Committee has reason to suppose that live loads assumed for buildings of similar occupancies vary in the case of different departments. A fair measure of agreement has been reached in respect of loadings on structures in the draft code IS : 875. The Government may advise all departments and State Governments to follow these standards as far as possible. This measure is technical.

11. At present design of steel structures is generally being done on the basis of out-moded codes. The Indian Standards Institution's Code (I.S. 800-1956) is an improvement on this code in several respects. The Government may request and make it mandatory on all departments to follow this code with immediate effect. This measure though technical needs administrative backing.

12. It will be seen from recommendations regarding use or saving of reinforcing or structural steel in buildings of different types that where use of structural steel is unavoidable welding is preferred to rivetting from considerations of steel economy.

    The Committee recommends that the Government may direct all departments that where structural steel is used, welded construction by competent welders should be accepted as an alternative and in preference to (if cost is the same for both) rivetted constructions.

    For this purpose designs on recognised principles of plastic theory should also be accepted. The measure is technical but requires administrative backing.

13. The Committee considers that in order to inculcate in the authorities concerned a direct sense of responsibility in the matter of rational use of steel, it will be advisable if the officer approving the design, records in each major design, a certificate to the effect (i) that the use of structural steel has been avoided wherever possible and limited to the minimum in other cases and (ii) that the load stresses and design practices adopted are in conformity with I.S. 800-1956.

It is further considered that similar certificates from a Chartered Engineer may be insisted upon in respect of all designs in private sector in which substantial quantities of structural steel is released either by the Provincial Iron and Steel Controller or by the Ministry of Commerce and Industry.

14. The Committee considered a proposal that in the present context of acute steel shortage, the permissible stresses in M.S. reinforcements in R.C.C. work may be increased; the Committee recommends that this question may be referred to the concerned Committee of the Indian Standards Institution for their very early consideration and decision.

15. About one third of the quantity of M.S. rods and bars are at present marketed as un-tested. Permissible stress adopted for this category of steel by some departments is only 16,000 lbs. per square inch. Most of these rods are rolled from billets slightly falling short of the standard specifications. The Committee feels that the Iron and Steel Controller may arrange to market this steel as 'tested' but certified to a lower class, say Class II, with guaranteed physical properties. The permissible stress for reinforcing rods of this class shall be considered and laid down by the relevant Committee of the Indian Standards Institution.

16. The Committee observes that considerable economies in cost and in steel will arise out of rational design of foundations and structures. For this purpose the Committee recommends (1) that persons be specially trained as design engineers for structures and foundations and that (2) a specialist individual or body be created for consultations in matters arising out of design of steel and R.C.C. structures and foundations. The Committee further recommends that the National Buildings Organisation will be the appropriate body to contain these specialists. This measure is administrative in character.

17. The Committee has seen the preliminary study by the National Buildings Organisation regarding the consumption of cement and steel in 10 multi-storeyed buildings in Delhi and has noticed the wide variations in the use of materials. The Committee feels that most design authorities could keep target figures for use of steel for various types of buildings from analysis of buildings already designed, and the designers should see that these target figures are bettered every time. Periodical publication of such figures by a body like the National Buildings Organisation will be helpful in the sharing of such knowledge.

18. The Committee feels that the information on use of twisted steel made available to them was insufficient to arrive at firm conclusions and that more comprehensive information supported by test results may be collected before large scale use of this could be advocated. The National Buildings Organisation and the Central Building Research Institute will collaborate on this project.

Appendix 3

Saving in Structural Steel through Standardization[*]

Recommendations:

Several important aspects of steel economy have been thrown up by the present study. The following recommendations, arising out of these considerations, merit urgent attention of the Government of India, and the producers and users of steel.

1. The study confirms that Indian Standard steel sections are more efficient than sections hitherto used in the country or overseas thus resulting in substantial saving in steel. It is important that the integrated steel plants in the country should switch over to the production of Indian Standard sections, particularly the light weight beams and channels (ISLB and ISLC) which contribute to the maximum saving of steel.
2. The rationalized list of steel sections for immediate production in the country was recommended by a committee under the aegis of the Iron and Steel Controller, Government of India. This recommendation is besed on the study made by the Committee on Steel Rationalization of the Indian Engineering Association. It is essential that a more comprehentive study should be made in order to consider the possibility of reducing the number of steel sections now included in various Indian Standards.
3. Although the Indian Standards for beam and channel sections were formulated in 1957 in consultation with the producers, the steel mills have not been able to produce so far the light weight sections. The main reasons advanced by the steel mills have been extensive roll wear and loss in production. It is essential that the technical committee of ISI should review the profile details of the light weight sections in the light of experience gained and modify them so that these could be produced in the country on economical basis.
4. It is essential that all design offices should use Indian Standard Codes of Practice for design of steel structures.
5. Preparation of handbooks for Structural Engineers was one of the important items included in the Steel Economy Programme of ISI. So far, only four handbooks have been published. It is important that ISI should expedite preparation of all the handbooks so that the Indian Standards published can be properly applied in actual practice.
6. As substantial saving in steel can be achieved through adoption of welding, use of welded structures should be encouraged. Indian Standards covering all aspects of welding have already been published. The following measures should be adopted to implement these standards:
    (a) Existing facilities for training and testing of welders should be enlarged so that competent welders are available in large numbers to the fabricating industry;

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[*] Published by the National Council of Applied Economic Research.

(b) Steels of weldable quality should be made available in sufficient quantities;

(c) Arrangements should be made for the manufacture of electrode quality steel to avoid import of such steel and/or electrodes; and

(d) Capacity for fabrication of welded structures should be increased.

7. Tubular structures should be used in all locations where heavy loads, such as those due to cranes, are not encountered. In order to encourage the use of tubular structures, tubes conforming to ISI: 1161-1963 should be made available to the users in sufficient quantities. As tubes of sizes larger than 6 in. dia. are not being manufactured in the country at present, spans of tubular structures have been limited to 40 ft. Steps should be taken to produce tubes of larger diameters to enable wider adoption of tubular structures.

8. The use of cold formed light-gauge steel sections contributes to the maximum percentage savings in steel. These sections should be used for purlins in all steel structures. They should also be used for all other components of structures where concentrated loads, such as those due to cranes, are not encountered. Production of cold formed light-gauge sections should be stepped up in order to encourage use of these sections in structures. Steel strip conforming to IS : 1079-1963[2] should be made available in sufficient quantities for cold forming into shapes specified in IS : 1811-1961[3]. Although the locations where tubular structures and cold formed light-gauge sections could be used are more or less identical, as far as possible, preference should be given to cold formed light-gauge sections in structures in the interest of greater economy in steel.

9. As cold formed light-gauge sections are produced very thin steel strips, it is important that suitable corrosion protective measures are adopted. The ISI should expedite formulation of codes of practice for protection of light-gauge steel structures.

10. It is also important that all Indian Standards relating to production and use of steel should form part of the curricular for study in all the engineering colleges and other technical institutions as this would ensure wider implementation of these standards.

11. Although the resultant savings due to implementation of IS : 1570-1961 has not been taken into account in this study, it is important that the Government should take steps to ensure that only steels conforming to this standard are manufactured and used in the country in order to derive the maximum benefit from standardization and rationalization of alloy and special steels. Further, wherever foreign countries collaborate in the various industrial undertakings it should be ensured that steels conforming to IS : 1570-1961 are used.

1. Steel tubes for structural purposes.
2. Hot-rolled carbon steel sheet and strip.
3. Cold formed light gauge structural steel sections, and
4. Schedules for wrought steels for general engineering purposes.

Contemporary World Engineering Project Series—32

Members are invited to contribute to this Series special articles featuring major engineering projects with which they have been associated in any manner. Articles should be preferably accompanied by photographs and illustrative sketches.

'AEROTRAIN'—TRAIN WITHOUT WHEELS

P. Joubert

Non-member

It looks as though a new form of transport for land and even water transport is going to take over quite soon in certain cases from wheels.

Loads will be made to glide along on an air cushion. This sounds quite paradoxical but on second thoughts one realizes that it is quite possible. Air is a fluid like water, only not so dense, but it can carry aircraft weighing tons just as water keeps boats afloat. The air-gun shoots bullets and a tornado can lift very heavy weights.

Now vehicles on wheels are slowed down by multiple friction caused by these circular carriers. There is friction at axles and with the ground and its rough places. Although friction with air does exist, it is considerably less than in the case of vehicles on wheels.

Precursors

Since the beginning of the century, inventors have attempted to eliminate wheel friction by using a fluid in their place. Louis Girard, for instance, had worked on gliding with a 'water cushion'. Later on, Therio took the idea up again but advocated an 'air cushion' for the first time, which meant actually creating carrying surfaces by blowing air along with great force. So, between the vehicle and the ground there was a free space of a few centimetres only forming a 'cushion' on which the vehicles glides along more easily than on oil, and practically without resistance whereas on wheels this increases according to the square of the speed, which is considerable in fast modern vehicles.

Taking into account this principle of the 'cushion' which can replace the wheel that develop greater and greater resistance at high speeds, work on aerogliders has been going on for the past ten years. It was practically impossible to build them in the days of Louis Girard on account of the weight and poor performances of engines then, but it is now possible with lighter engines and improved compressors. In the last ten years vehicles have been produced that can travel without wheels on land and on water. One of these is the 'hovercraft' which is going to be in regular service over the English Channel in a few months' time, doing the crossing between France and

England in twenty minutes. This method of gliding on air is becoming so general that a manufacturer of vacuum cleaners has adopted it to replace the small wheels for moving his appliance about with!

Using this same new principle for lifting vehicles, Jean Bertin, a French engineer, has produced the train on an air cushion, the 'Aerotrain' which has just undergone its first tests.

First tests

South of the Chevreuse valley near Paris, from Limours to Gometz-le-Châtel, an experimental line has been built, 6 km. long. Instead of the conventional railway track there is a single concrete rail. It resembles a girder shaped like a 'T' upside down. The vertical bar is the guiding rail. The horizontal wings form a base for the vehicles. On both these an air cushion is introduced and kept under pressure between the base of the vehicle and the single wall of the track.

Tests are being carried out on this cement track with half-size prototype carriages for six people only whereas the real carriages are designed to hold 100. All are driven by aircraft propellers, lifted and guided by the air cushion on the concrete rail. Prototype tests are carried out at 200 km. per hr. but the final train is being designed to do 400 km. per hr.

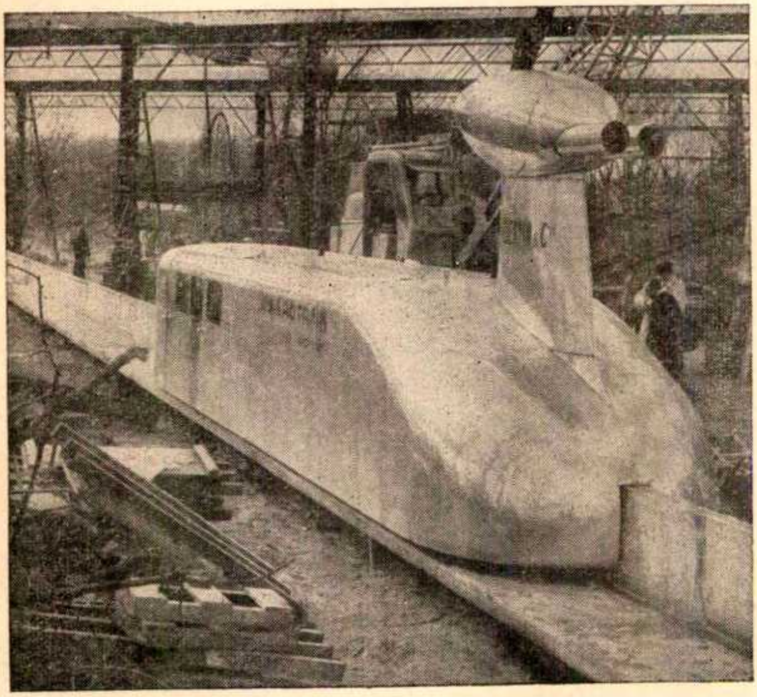

Fig. 1

The experimental aerotrain in the making

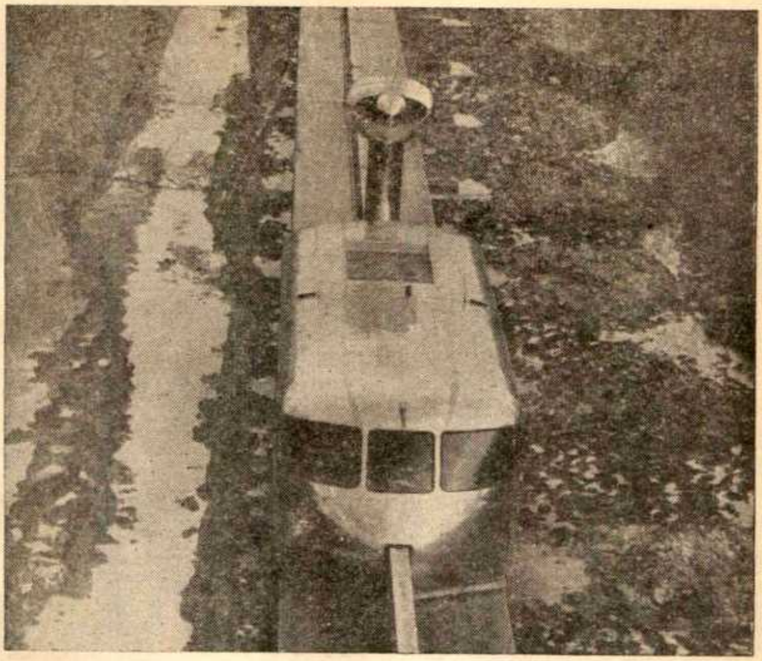

Fig. 2

The aerotrain on a trial run

These tests on the 6-km. track will make it possible to confirm the theoretical calculations of the engineers and to check stability, braking and the safety factor. The propeller and compressors are driven by aircraft engines. Since the weight of the vehicle is spread evenly over a long surface of track, this latter is comparatively light. Furthermore, the fact that there is only one means that it can be constructed easily as a superstructure on columns well spaced out and this simplifies the ground-plan problem.

The track is 1.80 m. broad and has 6 m. long sections. Assembling, now being operated at Limours, is carried out on 50 cm. high columns for experimental purposes, but it is easy to make taller ones. The track will soon be completed and the experimental vehicle is ready. In a very short time details as to the actual performance of this 'revolutionary' train of the future will be known.

A solution for the future

Quite certainly, if tests bear out laboratory work, this unusual form of transport by trains without wheels will be the solution for transport in the future over distances too short to justify the use of aircraft, between towns less than 500 km. apart, which will then be connected by far quicker and quieter transport than the trains now running and at the same cost if not more cheaply. The aerotrain will not however rule out trains for short distances and for goods transport. It will occupy an intermediary position between train and the plane. It will also be a fast way of connecting city

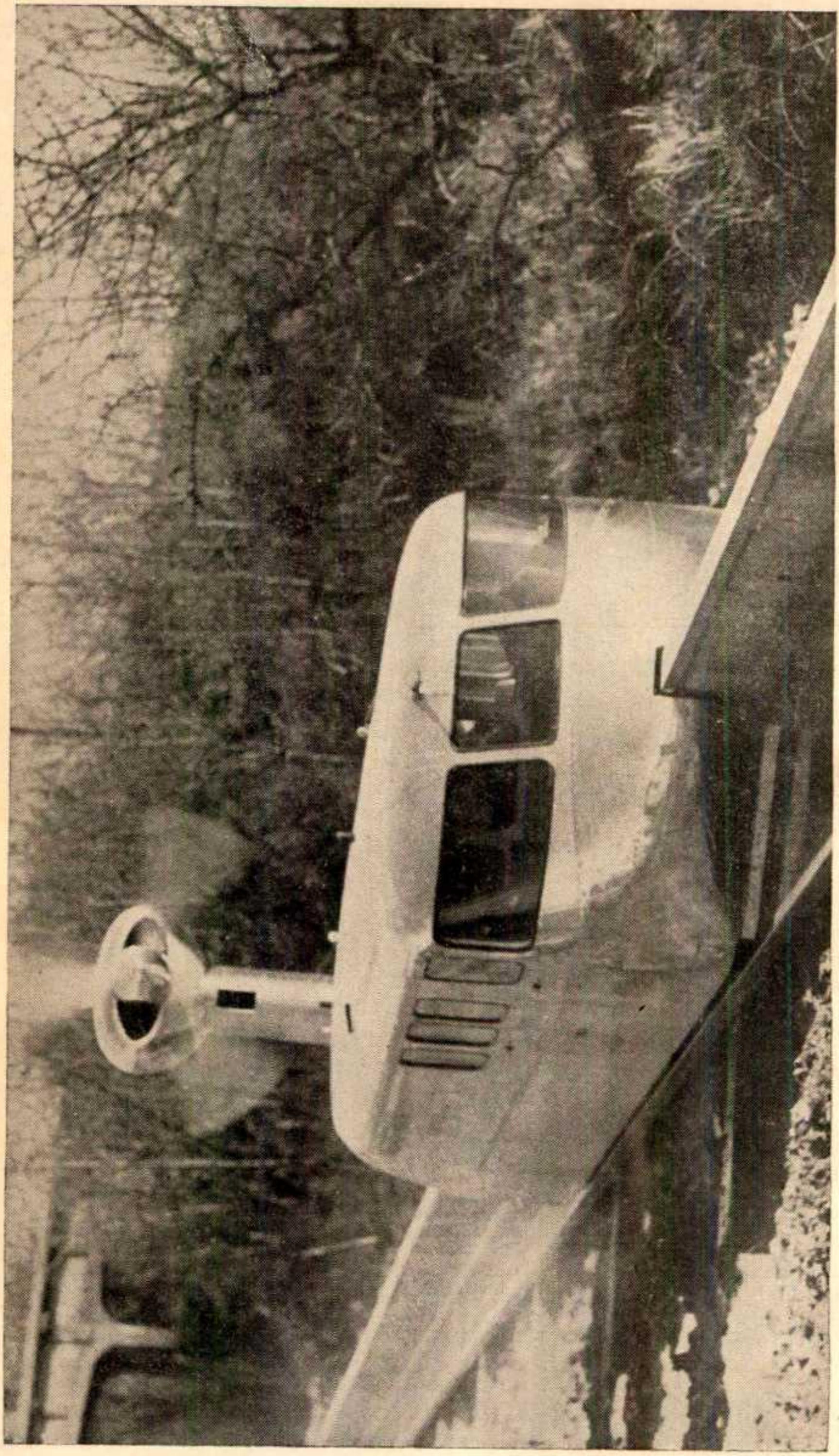

Fig. 3

The experimental aerotrain—a closer view centres with aerodromes that are not always close to built-up areas on account of the vast surfaces required by the big supersonic airliners.

It is already possible to calculate time the aerotrain will save on some runs. The Paris-Orly airport run will take 5 min. It will take 25 min. from Lyons to Grenoble, 30 min. from Paris to Orleans, 37 min. from Bordeaux to Périgueux and 1 hr. from Paris to Lyons.

The aerotrain research office has already been asked for surveys for lines by many foreign countries including the United States. The first Paris-Saint-Germain train was an event that caused a sensation. Is this likely to occur on the occasion of the first aerotrain running between Limours and Gometz-le-Châtel? At any rate it will mark an important stage in the history of land transport.

ADDRESSES OF CHAIRMEN AT THE ANNUAL GENERAL MEETINGS OF THE LOCAL CENTRES

Madhya Pradesh Centre

Chairman's address by Dr. V. M. Dokras, M.I.E., at the 7th Annual General Meeting of the Centre on March 10, 1966

Dr. Dokras thanked the members of the Centre for electing him Chairman for the second time, for 1966-67.

Delivering the Chairman's address, Dr. Dokras said, 'I intend to address you with some of my thoughts on technical education *vis-à-vis* the present situation in our country.

The dream of peaceful development of our economic resources to increase our standard of life, was rudely shattered by recent happenings, and since then there has started a chain of re-thinking and reshaping our Plans to meet the new situation.

As far as the technical man is concerned, he is as much required in war as in peace. The knowledge he has, the skills which he develops can be utilized to produce goods which will go to destroy or to sustain. The necessary difference is one of attitudes and aims. Our lack of emphasis on war-like projects and activities has now changed and we have been forced to prepare for the defence of our motherland.

With the new emphasis, development plans have to be redrawn taking into consideration the following broad patterns:

(a) Power,

(b) Communications and transport,

(c) Agriculture and food, and

(d) Industry including defence on all the three fronts.

With this orientation, it is but natural that with our limited resources, some unavoidable cuts have to be imposed on our long term programmes of economic development, as well as in addition a new thinking will have to be brought to bear on the training of technical persons in a hurry.

Normally, the training of artisans, technicians and engineers in our country is not particularly oriented towards a significant job the person shall be doing after he goes out. The emphasis is on making of a general, all round product who with some training will be able to fit in the production assembly line. This has two drawbacks. The first being that out of the total instruction of the student, a very large part is never required or used by him during his working life and thus is a waste as far as he is concerned, and secondly, in this process a large time is wasted making the person available for production work. In addition to this a considerable wastage of effort takes place, while the person may try to fit in the new work unsuccessfully.

We have neither a very large industrial area so that any skill obtained will be utilizable because of a large potential of opportunities, nor can we adopt the completely State dominated system of production, which enables one to predict accurately the number and categories of technical personnel. What then must we do?

A solution of this most important problem will, firstly, enable us to train persons for a particular job, and secondly, make him usefully available as soon as his training is over. An attempt can, therefore, be made to rethink and redraw some of our courses, keeping in view the skills required for specific narrow job employed in specific industries, or production areas. This will enable considerable slashing down of the general course making it more particularised. The build up of such a course has to follow the institution as well as employer or industry participation. It is on the basis of such a collaboration that the superstructure can be built; which shall be found really useful.

The need for this rethinking can be appreciated if one looks up the advertisements issued by industry. Most of them want recruits, who already have 3-4 years of practical experience. Such persons do not exist at present, since the expansion in technical education has come about only recently. There has arisen a peculiar situation of manpower shortage as well as technical unemployment.

The expansion in the field of technical education both at the degree level as well as at diploma level has been beyond expectation with 23,480 intake for degree and 45,843 for diploma course in 1964. As against this the estimated outturn, figures can be calculated with the present estimated wastage of 15% for colleges and 40% for polytechnics. With better facilities and teachers this wastage may be reduced. But, when these students pass out 3-5 years hence, they shall still be without the practical experience needed in jobs provided by industry. This situation has to be appreciated in that if 3 years practical experience is a must, the product of 1964 shall only be available in 1970-72. What are we going to do till then?

It is clear that there has been worthwhile quantitative expansion, but most of the courses followed today have the same emphasis as courses ten or fifteen years back. A time has come for the educationists and the industry to pool their thinking together to deliver the much required technical man who can be employable as soon as he is out of the institution in addition to the standard required. This will entail a qualitative thinking of no mean order.

The time has also come for starting short term courses in narrow specialities at different levels. The course could be put across while participating in the production process, the participation, of course, will be a matter of detail. It has, however, to be carefully noted that a shop or an assembly line can be organised properly, with the knowledge of skills, semi-skills or unskills available throughout the year. In this process if a certain number of trainees are to be taken in, their number, the nature of skills available with them and to be imparted to them should be a constant factor throughout the year and be not seasonal. It is very difficult for the foreman to disarrange his fixed activities seasonally to take care of trainees. This should be a permanent feature built in the productive schedule. It is only on such type of organisational pattern that more realistic training programmes can be built up where the trainee is supposed to be best utilized when absent, or remains merely a distant onlooker.

It is this new approach and a close interaction between the industry and institution which will be necessary in reorganising the technical education programmes to meet our immediate specific and future needs of technical personnel.

Summaries of Papers Published in the Journal, vol. 46, no. 12, pt. EL 6, August 1966

ELECTRICAL ENGINEERING GROUP

530.17 : 69.001.5

1. Transient Thermal Response of Building Fabrics by Electrical Analogue Method. (Mrs.) Kamlesh Arora, *Non-member*

This paper deals with the application of electrical analogue method for the study of transient thermal response of homogeneous and composite building fabrics. The building elements are represented on the analogue by lumped *R-C* network corresponding to their thermo-physical properties. An electrical step-voltage forms the input function and the response of the network with resistive terminations, simulating the surface film resistances, is studied for a set of three system functions, *i.e.*, a transfer-point function and two driving-point functions. The response curves are observed on an oscilloscope screen with calibrated time base and recorded photographically. On valid check on the results is that the final response value should be equal to the steady state value. From the recorded step-response curves, the salient transient features like delay time, rise time and time constant are derived.

621.315.17

2. A Modified Method of Calculation for Obtaining Stringing Chart of Overhead Transmission Line. R. N. Basu, *Non-member,* **and S. N. Dutta,** *Non-member*

This paper discusses a modified method of calculations for obtaining variations of sag and tension of overhead transmission lines with the variation of temperature. The necessary equations are derived and, instead of solving them directly, suitable values of tension or sag are assumed to calculate the corresponding values of temperature, thereby reducing the labour involved appreciably. The method is illustrated with an example and the results are compared with those obtained by the normally used method of solving cubic equations. Also, the method is extended by finding out a simple expression for the critical value of stress, which, at the critical temperature, remains constant for all values of span. The critical value thus calculated is also checked for the example by plotting a number of stress *vs.* temperature curves corresponding to different spans.

621.317.43 : 621.317.784 : 621.3.0834

3. Measurement of Incremental Magnetic Loss by Bridge and Wattmeter Methods. R. K. Mondal, *Non-member,* **S. N. Bhattacharyya,** *Associate Member* **and Prof. J. K. Choudhury,** *Associate Member*

This paper reviews the effect of harmonics contained in the excitation current of a magnetic sample on the measurement of core loss by the bridge and the wattmeter methods, particularly under incremental conditions. It describes a novel circuit for incremental core loss measurement by a combined Owen-bridge-cum-electrostatic-wattmeter method by which the influence of harmonic power loss in iron testing is explained both qualitatively and quantitatively. It has been further shown that a particular form of bridged-T may be used for incremental core loss measurement wherein the effects of harmonics will be relatively much smaller than in conventional bridges like Owen, Hay, etc.

621-52.001

4. Transfer Function of Two-Phase Servomotor. J. S. Gupta, *Associate Member*

A large proportion of computers and servomechanism in current use in industrial and military control application comprises A.C. systems. The actuator requirements for low-power systems are satisfactorily met by a two-phase induction motor. This paper briefly reviews the different methods for determining the transfer function of a two-phase servomotor and suggests a simple experimental method suitable for application to all types of A.C. servomotors.

621.33.001

5. Minimum Transit Time and Electricity for City Electric Traction. Dr. V. K. Jain, *Associate Member,* **and W. E. Thompson,** *Non-member*

In this paper, the modern theory of optimal control is employed to investigate the minimum transition-time and electricity consumption in city traction. For minimum time, the nature of the controls established as maximum acceleration followed by maximum deceleration. For minimum transition-time and electricity consumption, the nature of control is shown to consist of maximum acceleration preceding coasting followed by maximum deceleration. The durations of acceleration, coasting and decelerations are calculated with the help of Pontryagin's adjoint equations. It is shown that for any specific case certain graphs can be obtained which directly give these durations for a specified transit distance.

621.316.925.45

6. A Generalized Theory of Protective Relays and Its Application to Distance Protection—2: Application. Dr. S. P. Patra, *Associate Member,* **and S. R. Bandyopadhyay,** *Non-member*

This part of the paper deals with the practical verification of the generalized theory enunciated in Part 1 (*Journal,* vol. 46, no. 8, pt. EL4, April 1966, p. 260). This verification has been confined to the field of distance protection. For this purpose, a transistorized phase comparator and a rectifier-bridge amplitude comparator have been used. The experimental results have also been presented. The operation of induction-cup relay used for distance protection has also been explained by the generalized theory.

621.314.1 : 621.3.012.8

7. Equivalent Circuit for a Multi-Winding Transformer. Dr. P. V. Ratnam, *Non-member,* **and C. K. Sarma,** *Non-member*

This paper presents an analysis of the transient performance of a multi-winding $(n-1)$ transformer. It is shown that such a transformer can be replaced, in the general case, by an $(n+1)$ terminal delta-connected circuit having impedances directly connecting all possible pairs of the $(n+1)$ terminals. The conditions under which the $(n+1)$ terminal data can be converted into a $(n+1)$ terminal star, having $(n+1)$ impedances only, have also been derived. The practical applications of the equivalent circuit are also discussed.

621.313.13 : 669.18

8. Determination and Verification of Capacities of Main Drive Motors of Hot Reversing Steel Mills. B. P. Sarker, *Associate Member*

Due to increasing demands of rolled steel products engineers are frequently required to verify the capacities of main drive motors of rolling mills or to determine the capacities of motors for new mills. This paper briefly reviews the methods of checking/determining the capacities of the hot reversing mill motors theoretically as well as from oscillograms of actual current loading.

621.319.4.004.14

9. Application of a Capacitor with the Arno 1 : 3 Phase Convertor. T. V. Sreenivasan, *Associate Member*

If a normal induction motor, with three identical stator windings, is used as an Arno 1 : 3 phase convertor, excessive voltage unbalance under load will result. This can be reduced by the application of a capacitor. This paper derives the expressions for voltage and current under these conditions and presents a graphical method for determining the same. Some experimental results are given, including the harmonic content of the output voltage. It is concluded that even with a capacitor, the induction motor has to be specially designed for low leakage reactances, to reduce the harmonic content of the output voltage.

621.311 : 621.3.012

10. Application of Equivalence Technique in Linear Graph Theory to Reduction Process in a Power System. Prof. S. Srinivasan, *Member,* **V. N. Sujeer,** *Associate Member,* **and K. Thulasiraman,** *Non-member*

This paper deals with the application of a new equivalence technique in linear graph theory to the reduction process in a power system, treated as a linear graph with oriented elements. The formulation of equations in the nodal form, selection of suitable subgraphs or zones and computation of data for individual zones without ever combining them into submatrices for the whole system enables the reduction of the power system into its final Daisy-equivalent. An illustrative example is worked out for a typical power system with eight generating stations and thirty-six elements.

621.316.57

11. A Circuit for the Synthetic Testing of Vacuum Circuit Breaker—2: The Control Circuit. D. G. Tamaskar, *Associate Member*

In this part of the paper, which is in continuation of the earlier part dealing with the main circuit for synthetic testing of vacuum circuit-breakers (*vide Journal,* vol. 46, no. 8, pt. EL4, April 1966, p. 329), the main features involved in the testing are dealt with.

621.319.4

12. Selection of Capacitors for Rectifier Devices. Prof. B. M. Tareev, *Non-member,* **and M. M. Lerner,** *Non-member*

For a correct choice of the best types of electrical capacitors to be utilized in rectifier circuits, one has to know well both the kinds and properties of capacitors now in manufacture and the regimes of operation of capacitors in these circuits. So far neither the specialists in the field of electrical circuits nor the specialists in electrical capacitors have duly examined the problem of the most expedient choice of capacitors for rectifier devices and also for some other electrical devices. In this paper, the authors have attempted to do the first step in the solution of the above-mentioned problem. It gives the formulae relating the characteristics of capacitors to regimes of their operation for rectifier devices of Graetz and Greinachar, the generalized characteristics determining the cost of capacitors, and the ways to choose the regimes of operation most economical from the view point of cost.

621.316.99.001

13. Grounding Resistance of Straight Horizontal Conductor in Non-Uniform Soil. B. Thapar, *Non-member*

A horizontaly buried wire is used in many cases to obtain low grounding resistance. This paper develops a method to determine more accurately the resistance of such grounding electrodes. The non-uniform soil resistivity is represented by two-layer stratified earth, which can represent most of the soil conditions that normally occur in practice. The dimensions of the electrode and its depth of burial considered are those usually encountered in practice.

NUCLEAR ENGINEERING GROUP

621.039.532.2

14. Stability Boundaries Variation due to Delayed Neutron Representation in a Graphite Power Reactor. V. R. Sastry, *Non-member*, and G. S. Deep, *Non-member*

The paper compares the variation of upper and lower limits for the controller gain for the stable operation of a reactor with the help of two mathematical models: with the effect of delayed neutrons, and with only an effective mean neutron life time of 70 milli-sec. and without delayed neutrons. The present a mathematical model consists of two active regions. Each region is simulated as a point reactor coupled to the other region by neutron diffusion. Two groups of delayed neutrons equivalent to the six groups of delayed neutrons are assumed in the model. The error signal for the control system is derived from the change in mean fuel temperature. The analogue computer results indicate that the controller gain at the upper stability boundary is increased nearly by a factor of 5.6 for $\alpha_m=0$ and 4.6 for $\alpha_m=16\times10^{-5}$ δK per °C. when delayed neutron effects are considered. The period of oscillations at this boundary is reduced to about 31 sec., *i.e.*, nearly to one-third of the value obtained without delayed neutron representation in the model. The lower limit for the controller gain and the period of oscillations at this boundary are not significantly affected. Some simplification of the present model and their limitations are discussed. The effects of incorporation of xenon variations are also indicated. During preliminary design studies, by choice of a reactor model without xenon variations or delayed neutrons, it is possible, in certain investigations, to achieve some economy in the computing amplifiers in the case of analogue computers and computing time in the case of digital computers.

INSTITUTION NOTICES

Seminar on 'Engineering Industries and Their Development', 1968

An announcement on the above Seminar, to be held by the Local Centres at the time of their forthcoming Annual General Meetings and concurrently at the 48th Annual Convention of the Institution, has been made on page 35 of the *Bulletin* dated July 1966.

The President has approved the inclusion of the following topics for discussion at the Seminar.

1. Role of engineering industry in defence supplies
2. Role of engineering industry in augmenting food supply

3. Role of engineering industry in augmenting export
4. Import substitution in engineering industries
5. Role of indigenous design and consultancy in engineering industries
6. Role of foreign collaborators in developing engineering industries
7. Prospects and problems of engineering industries
8. Role of the Institution in the development of engineering industries
9. Role of standardization in development of engineering industry.
10. Technical training and education for development of engineering industries

Further details of the Seminar will be published in the *Bulletin* for information of members as and when available.

Draft Indian Standards

The following draft Indian Standards have been issued recently.

1. Draft Indian Standard Methods of Test for Soils: (i) Part XVII—Laboratory Determination of Permeability—Doc: BDC 23 (987); and (ii) Part XXIX—Determination of Linear Shrinkage—Doc: BDC 23 (1042).

Members may send their comments on this draft standard before September 7, 1966, to Shri C. G. Swaminathan (*A.M.*), Assistant Director, Central Road Research Institute, New Delhi 20, who is the Institution representative on the Sectional Committee dealing with this draft Standard.

2. Draft Indian Standard Specification for (i) Vitreous Sanitary Appliance (Vitreous China): Part 1—General Requirements (Revision of I.S.: 2556-1963—Doc: BDC 3 (1039); (ii) Part 2—Specific Requirements of Wash Down Water-Closets (Revision of I.S.: 2556-1963)—Doc: BDC 3 (10403; and (iii) Part 3—Specific Requirements for Squatting Pans and Traps (Revision of I.S.: 2556-1963)—Doc: BDC 3 (1041).

Members may send their comments on this draft Standard before September 15, 1966, to Shri B. B. Rau (*A.M.*), Deputy Assistant Director General (Public Health Engineering), Central Public Health Engineering Organization, Wing 8, Patiala House Annexe, Tilak Marg, New Delhi 1, who is the Institution representative on the Sectional Committee dealing with those draft Standards.

3. Draft Indian Standard on Safety Code for Working in Compressed Air—Doc. BDC 45 (955).

This standard lays down the safety requirements for work in compressed air undertaken in construction works such as bridge foundations, docks and tunnels.

Members may send their comments on this draft standard before September 20, 1966, to Prof. R. N. Dogra (*M*), Principal, College of Engineering and Technology, New Delhi 16, who is the Institution representative on the Sectional Committee dealing with this draft standard.

Copies of the draft Standards may be obtained from the office of Indian Standards Institution, 'Manak Bhavan', 9 Bahadur Shah Zafar Marg, New Delhi 1, or from its branch offices at Bombay Mutual Terrace, Sandhurst Bridge, Bombay 7; 5 Chowringhee Approach, Calcutta 13, 14/69 Civil Lines, Kanpur, or 54 General Patters Road, Madras 2.

FORTHCOMING EVENTS

National Metallurgists Day, Rourkela, November 14-16, 1966

The Fourth National Metallurgists Day will be held at Rourkela from November 14 to 16, 1966. Sponsored by the Indian Institute of Metals and the Rourkela Steel Plant, the function is expected to be inaugurated by Shri T. N. Singh, Union Minister of State for Steel.

The 20th Annual Technical Meeting of the Indian Institute of Metals will also be held concurrently on these days and a Symposium on 'Use of Non-Ferrous Metals in Engineering Industry' has been included in the programme. Papers of not more than 5,000 words in length are invited for presentation at the Symposium,

Further details can be obtained from The Indian Institute of Metals, 31 Chowringhee Road, Calcutta 16.

Tenth Indian Standards Convention, Ernakulam, December 26-31, 1966

The Tenth Indian Standards Convention will be held at Ernakulam from December 26 to 31, 1966. The programme of technical sessions includes discussion on the following topics: (i) Standardization for Import Substitution; (ii) Metric Changeover—Remaining Tasks; (iii) Company Standardization and Productivity; (iv) Standardization and Small Scale Industries; (v) Training in Standardization Technology; (vi) Standards for Technical Editors and Publishers.

Papers of not more than 2,500 words in length, having direct bearing on some related aspect of standardization work are invited for presentation in these sessions.

Further details can be had from the Director General, Indian Standards Institution, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 1.

International Congress and Exhibition P.R.P. Automation, Antwerp, October 24-28, 1966

The Regeltechniek en Automatizering of the Technologisch Instituut van de Koninklijke Vlaamse Ingenieursvereniging in cooperation with the Belgisch Instituut voon Regeltechnick en Automatizering is organising an International Congress and Exhibition on 'Instrumentation and Automation in the Paper, Rubber and Plastics Industries'. The Congress will be held in eleven sessions dealing with the subjects: (i) Measurement and Control of Various Parameters; (ii) Data Acquisition and Process Control by means of

Automatic Computers; (iii) Measurement and Control of Various Parameters ; (iv) Application of Computers in the Paper Industries; (v) Control of the Material Web; (vi) Application of Computers in the Paper Industries; (vii) Measurement and Control Problems in the Plastic Industries; (viii) Measurement Techniques for Quality Control; (ix) Quality Control during Processing; (x) Quality Control during Processing (continued); and (xi) Data Acquisition and Process Control by means of Automatic Computers (continued).

Further details can be obtained from P.R.P. Automation, Ingeniewrshuis, Jan van Rijswijcklaar 58, Antwerpen, Belgium.

75th Anniversary of The South African Institute of Mechanical Engineers, June 1967

The South African Institute of Mechanical Engineers founded in June 1892 will be celebrating its 75th Anniversary in June 1967. Arrangements are being made to commemorate that event which will also have as a major object the attraction of youth to the profession of mechanical engineering. A Symposium willl also be organized at which prominent South African will present papers of general interest.

Further details can be obtained from the Secretary. The South African Institution of Mechanical Engineers, Kelvin House, 2 Hollard Street, Johannesburg, Transvaal, South Africa.

Fifth Congress of the International Association for Analogue Computation, Lausanne, August 28-September 2, 1967

The Fifth Congress of the International Association for Analogue Computation (AICA) will be held in Lausanne, Switzerland from August 28-September 2, 1967. Organized by the Swiss Federation of Automatic Comtrol (SGA), the Congress will deal with the broad categories of the subject: (i) New Mathematical Techniques for Analogue and Hybrid Computation—Theory ; (ii) Applications of Analogue and Hybrid Computers; (iii) Components and Systems of Analogue and Hybrid Computers; and (iv) Digital and Hybrid Software.

Authors wishing to offer papers for inclusion in the programme of the 5th AICA Congress should submit a provisional abstract to the Selection Committee before October 15, 1966.

Further details can be obtained from Sekretariat der schweizerischen Gesellschaft fur Automatik, Wasserwerkstrasse 53, CH 8006 Zurich (Switzerland).

JSME Semi-International Symposium, September 4-8, 1967, Tokyo

The Japan Society of Mechanical Engineers announces the 1967 Semi-International Symposium on selected subjects in mechanical engineering. The Symposium will be held in Tokyo from September 4-8, 1967, as a part of the special programme commemorating the 70th Anniversary of the Society The scientific programme for the symposium will cover the following topics in mechanical engineering.

Experimental Mechanics: (i) Experimental Stress Analysis; (ii) Material Testing; (iii) Mechanics of Materials and Plastic Working; (iv) Dynamics of Mechanical Components and Systems; and (v) Vibration, Impulse, Fatigue and Fracture.

Heat and Mass Transfer, Thermal Stress: (i) Heat and Mass Transfer in Flows, Change of Phase, and Liquid Metal; and (ii) Measurement and Analysis of Heat Conduction and Thermal Stress.

Gearing: (i) Gear Geometry; (ii) Gear Tooth Strength and Loading; (iii) Manufacturing; (iv) Gear Measurement; (v) Lubrication; (vi) Noise and Vibration; and (vii) Applications.

Offers of papers should be made not later than December 1, 1966, by sending two copies of abstract of about 500 words to the Symposium Committee. Further details can be obtained from JSME 1967 Semi-International Symposium Committee, The Japan Society of Mechanical Engineers, Nihon Kikaku Building, 1-24, 4 chome, Akasaka, Minato-ku, Tokyo, Japan.

Conference on Metering and Apparatus for Modern Electricity Supply Tariffs, London, October 31-November 1, 1967

A Conference on Metering and Apparatus for Modern Electricity Supply Tariffs will be held at the Institution of Electrical Engineers, London, from October 31 to November 1, 1967. The scope of the Conference will be as follows:

1. *Accountancy and Statistics*—(i) billing period; (ii) the use of prepayment methods and door-step billing; (iii) meter reading—conventional methods, remote reading and processing; (iv) data capture by magnetic storage or photographic methods; and (v) metering for a statistical, operational and planning purposes.
2. *Commercial*—(i) tariff building; (ii) consumer's load research (domestic, commercial and industrial); (iii) organizing statistical surveys; (iv) measurement of maximum demands; (v) load factor, power factor; (vi) effect of season of year; (vii) load consumption characteristics; (viii) measurement of kVA; (ix) assessment of effect of application of tariffs; and (x) economics of load control.
3. *Meter Engineering*—(i) design and production of metering and ancillary equipment special tariff meters: excess load meters: multirate meters: maximum demand meters; (ii) kW and kVA definitions and effects of wave-form; (iii) load splitting and time integration period; (iv) telemetry and telecontrol and load switching apparatus; and (v) equipment for meter reading and billing: outdoor metres: pre-payment meters: developments in bulk supply meters; outdoor and plug-in meters.
4. *Statutory*—(i) legal obligations; (ii) meter certification; (iii) permissible tolerances; (iv) legal requirements (special reference to

International Organization for Legal Metrology); (v) validity of certification; (vi) quality control limits for certification; (vii) International statutory units; and (viii) need for Internationally recognized standards.

Contributions of not more than 1,500 words are invited for inclusion in the programme. Intending authors should submit a synopsis of their proposed contributions, of about 200 words, by October 1, 1966, at the latest.

Further details can be obtained from The Secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C. 2.

BOOK ACKNOWLEDGMENTS

1. **Mechanical Drawing.** T. E. French and C. L. Svensen. *McGraw-Hill Book Co., Inc.*, $6.20, 6th edition, 1962. 560 pages.

This book explains the working drawings of mechanical engineering prepared according to the modern commercial practice. Chapters on Reading and Making Drawings, Electrical Drafting and Glossary of Shop Terms, Bibliography, Additional Tables, etc., and the appendix giving exhaustive references and American Standards for working drawings as well as the list of visual aids to illustrate the text, enhance the utility of the book.

2. **Complex Analysis.** L. V. Ahlfors. *McGraw-Hill Book Co., Inc.*, $8.95, 2nd edition, 1966. 317 pages.

This revised and enlarged edition of the book deals with the theory of analytic functions of one complex variable. The most important changes from the first edition include (i) the explanation of exponential and trignometric functions by means of power series, (ii) re-writing the introduction to point set topology, (iii) more direct approach to normal families of functions, (iv) addition of a short chapter on elliptic functions, and (v) enlarged exercise sections.

3. **A Textbook of Electrical Engineering.** B. L. Theraja. *S. Chand & Co.*, Rs. 25, 5th edition, 1965. 1630 pages.

This revised and enlarged edition of the book in rationalized M.K.S. system of units covers nearly the entire field of electrical engineering. It contains a large number of solved and unsolved problems on each topic.

4. **A Textbook of Engineering Physics.** B. L. Theraja. *S. Chand & Co.*, Rs. 17, 3rd edition, 1965. 819 pages.

In various chapters of this book, the author has elaborated the subjects of heat, light, sound, and thermodynamics with an engineering bias.

5. **Engineering Mechanics.** R. S. Barve. *B. I. Publications*, Bombay, Rs. 18.50, 1965. 429 pages.

This book, in metric system of units, outlines the fundamental principles of engineering mechanics.

6. **Steel Structures.** N. R. R. Rao. *Saroj Prakashan*, Allahabad. Rs. 10, 1964. 320 pages.

This book illustrates the application of the basic principles on the practical design problems of various structural elements.

7. **Textbook of Civil Engineering.** B. S. Goyal. *Saroj Prakashan*, Allahabad. Rs. 6.25, 2nd edition, 1965. 203 pages.

This book briefly provides the elementary knowledge in the areas of building construction, reinforced concrete, roads, water supply and sanitary engineering.

8. **Steam Tables.** J. P. Gupta. *Saroj Prakashan*, Allahabad. Rs. 1.50, 1966. 33 pages.

This small booklet gives the steam tables in British as well as metric system of units. Mollier's chart in metric system has also been appended to.

9. **Estimating and Costing for Mechanical Students.** J. P. Gupta. *Saroj Prakashan*, Allahabad. Rs. 6.25, 1965. 220 pages.

This book written in metric system of units gives an elementary knowledge on estimation and costing as applied to mechanical engineering.

10. **Bridge Engineering.** R. A. Agrawal and S. K. Sangal. *Saroj Prakashan*, Allahabad. Rs. 7.50, 5th edition, 1964. 248 pages.

This book deals with the design and construction of different types of bridges.

11. **A Practical Book of Workshop Technology.** S. N. Srivastava. *Saroj Prakashan*, Allahabad. Rs. 5, 1965. 144 pages.

This book briefly deals with engineering materials, measuring instruments, bench work, carpentry, foundry shop, smithy shop, riveting, welding processes, layout, and transmission of power.

12. **Workshop Management.** Y. S. Joshi. *Saroj Prakashan*, Allahabad. Rs. 6.25, 2nd edition, 1965. 296 pages.

This book deals with the problems concerning workshop management and organization.

12. **Civil Engineering Designs, Projects and Specifications.** L. S. Agarwal and M. S. Giri. *Saroj Prakashan*, Allahabad. Rs. 7.50, 1964. 240 pages.

This book deals with civil engineering works, *e.g.*, buildings, roads, bridges, irrigation works, etc. Chapters on specifications and contract system have also been included.

14. **Machine Drawing Exercise Book.** Dr. B. K. Gupta. *Saraj Prakashan*, Allahabad. Rs. 8, 1964. 139 pages.

This exercise-book in metric units contains many solved and unsolved problems and helpful formulae giving the proportions of various machine components like bolts, nuts, cotter pins, etc.

15. **Foundry Engineering.** P. L. Jain. *Technical Publishers of India*, Allahabad. Rs. 7.50, 1965. 216 pages.

This book contains useful knowledge of foundry engineering which comprises the basis of about the whole range of manufacturing activities.

PUBLICATIONS RECEIVED

A copy of the publication entitled 'The Wealth of India—Industrial Products, Part 6', of the Council of Scientific and Industrial Research, New Delhi, has been received. The publication is the sixth issue in series of the Dictionary of Indian Raw Materials and Industrial Products and includes articles dealing with twenty-eight different industries like machinery, petroleum refining, etc., commencing with letters M, N, O, and P (up to Pi).

A copy of the publication entitled 'Atoms in Germany' written by Robert Gerwin has been received from the Consulate of Federal Republic of Germany, Calcutta. It gives a report on the state and development of nuclear research and nuclear technology in the Federal Republic of Germany. A historical survey, brings out the details of the works done in Germany for more than three decades.

A copy of the 'Journal of Terramechanics—vol. 2, no. 2, 1955', published on behalf of the International Society for Terrain Vehicle Systems, has been received from Pergamon Press. The Journal contains technical papers concerning land locomotion, terrain-vehicle system, etc.

A copy of the 'Industrial Diamond Buyers' Guide', 4th edition, 1966, has been received from the Industrial Diamond Information Bureau, Arundel House, Kirby Street, London, E.C. 1. The continued growth of the industrial diamond tool industry is well-represented in its four sections: Company index, Products index, Trade names index, Geographical index. In the wake of increasing appreciation of diamond tools in engineering industries, this Guide is a welcome addition to the published literature on the subject.

PUBLICATIONS FOR SALE

1. **General Sir Arthur Cotton.** Lady Hope. Reprinted by The Institution of Engineers (India). 530 pages. Rs. 20.00.

Dr. K. L. Rao, the Union Minister of Irrigation and Power, recently wrote: 'Until about a hundred years ago, India was the victim of frequent famines. But thanks to the magnificent irrigation projects executed by brilliant British engineers like Sir Arthur Cotton in the South..................famine has practically vanished from the land'.

Reprinting the book, 'General Sir Arthur Cotton', the Institution has rightly paid homage to a great engineer whose genius and dedicated service stood between famine and prosperity. Presented in a pleasing format, the book is an invaluable possession to any engineer.

2. **Use of Fly Ash in Building Industry.** Published by The Institution of Engineers (India). 18 pages Rs. 2.50.

The contents of this monograph highlighting the features of the versatile building material, fly ash—an industrial waste produced in profusion in the thermal stations of our country and difficult of disposal as produced—comprise observations of a research team at the Central Building Research Institute, Roorkee.

EMPLOYMENT SERVICE

This service is intended for the benefit of members of the Institution and for the Government, Industrial and other organizations employing engineers. It is hoped that employers will make full use of this service to obtain their requirement.

A small charge of Rs. 5 per insertion will be made to members for notices appearing in the 'Situations Wanted' column.

In the 'Situations Vacant' column, a charge of Rs. 2 per line will be made.

Replies to advertisements should be addressed to Employment Service, The Institution of Engineers (India), P. O. Box No. 669, Calcutta, except where otherwise stated.

SITUATIONS WANTED

B.E. (CIVIL), 46 years, having 11 years experience in industrial structures (coal washeries, steel plant, etc.) concurrently one year in cross drainage work (syphons and aquaducts) in river valley project, 6 years in bridges (R.C.C. bridges with well foundations) and 6 years in common buildings (practising as consulting engineer) including several years work in contractors firms in top position with overall responsibilities of technical administration and execution of construction projects under turn-key and item-rate contracts, seeks change from November/December 1966. (Office ref. E.S. 242)

YOUNG REFRIGERATION & AIR CONDITIONING TECHNICIAN, age 30 years, Student of the Institution of Engineers (India), passed I.Sc. with Physics, Chemistry and Mathematics of Calcutta University; passed the diploma course in refrigeration and air conditioning conducted by the Indian Society of Refrigerating Engineers; nearly 9 years factory experience on production, maintenance, servicing, testing and inspection of all types and capacities of room and packaged type air-conditioners, water coolers, refrigerators, ice-cream cabinets, etc., has some design experience also; at present working as quality controller in a well-known refrigeration firm; opens for suitable engagement. (Office ref. E.S. 243)

MECHANICAL ENGINEER, H.N.C. (U.K.), Grad. I.E. (India), 36 years, having seven years experience of which six years in West Germany and in the U.K., in design, workshops, etc., seeks a senior position. (Office ref. E.S. 244)

ELECTRICAL ENGINEER, A.M.I.E., 38 years, having a total 15 years practical experience in the operation and electrical maintenance of a thermal power station consisting of high pressure boilers, pass-out type turbines, switchgear and other control systems; at present working as Shift Engineer drawing a total monthly emolument of Rs. 850, seeks a suitable job of similar nature or sales, etc., in South India; prepared to take training in new fields; salary expected Rs. 1,000 per month. (Office ref. E.S. 245).

Scheme of Institution Publications

Publication	Symbol	Frequency per year	Month of publication											
			January	February	March	April	May	June	July	August	*September	October	November	December
Bulletin	*BU*	12	BU5	BU6	BU7	BU8	BU9	BU10	BU11	BU12	BU1	BU2	BU3	BU4
Civil Engineering Division Part	*CI*	6	CI3		CI4		CI5		CI6		CI1		CI2	
Mechanical Engineering Division Part	*ME*	6	ME3		ME4		ME5		ME6		ME1		ME2	
Electrical Engineering Division Part	*EL*	6		EL3		EL4		EL5		EL6		EL1		EL2
Electronics & Tele-communication Engineering Division Part	*ET*	3	ET2				ET3				ET1			
Chemical Engineering Division Part	*CH*	3		CH2				CH3				CH1		
Mining and Metallurgy Division Part	*MM*	3			MM2				MM3				MM1	
Public Health Engineering Division Part	*PH*	3		PH2				PH3				PH1		
General Engineering Part	*GE*	3	GE2				GE3				GE1			
Hindi Section	*HI*	3				HI2				HI3				HI1

* A new volume commences in September each year and ends in August next year.

THE INSTITUTION OF ENGINEERS (INDIA)

8 Gokhale Road, Calcutta 20

November 1966 Examination

Programme

	S.T. 10.00 to 1.00	S.T. 2.00 to 5.00
	Studentship Examination	
Tuesday, November 15, 1966	English	Mathematics I
Wednesday, November 16, 1966	Mathematics II	Physics
Thursday, November 17, 1966	Chemistry	
	Associate Membership Examination—Section A	
Monday, November 7, 1966	Mathematics I	Mathematics II
Tuesday, November 8, 1966	Applied Mechanics	Principles and Applications of Electricity
Wednesday, November 9, 1966	Heat, Light and Sound	Engineering Drawing
Thursday, November 10, 1966	Strength of Materials	Elementary Surveying
	Associate Membership Examination—Section B	
Tuesday, November 15, 1966	Materials and Construction Mechanical Engineering Materials Electrical Engineering Materials Chemical Engineering Materials Principles and Practice of Coal Mining Mineral Dressing Electronics and Telecommunication Materials	Theory and Design of Structures Industrial Organization and Management Theory and Performance of Electric Machines Industrial Stoichiometry and Mechanics of Fluids Principles and Practice of Metal Mining Physical Metallurgy and Physical and Mechanical Testing of Metals
Wednesday, November 16, 1966	Structural Engineering Generation, Transmission and Distribution of Electric Power Diffusional Processes, Evaporation and Distillation Mine Ventilation, Explosions, Fire and Inundation Refractories Applied Electronics and Circuits	Surveying and Geodesy Theory of Machines Electric Traction Fuels and Combustion Mine Surveying Foundry Engineering Transmission Lines and Networks
Thursday, November 17, 1966	Hydraulics Industrial Engineering Illumination Engineering Elementary Electrical Engineering Mineral Dressing Practice Metallurgical Analysis Advanced Radio and Electronic Engineering	Highway Engineering Fuels and Refractories Radar Engineering and Microwave Techniques Workshop Technology
Friday, November 18, 1966	Civil Engineering Design and Drawing Mechanical Engineering Design and Drawing Electrical Engineering Design and Drawing Chemical Engineering Design and Drawing Electronics and Telecommunication Design and Drawing	(From 10 a.m. to 1 p.m. and 1.30 p.m. to 4 p.m.)
	Mining Machinery Physics of Metals	Generation, Distribution and Utilization of Power in Mines Metallurgy of Less Common Metals

Programme—(*contd.*)

Saturday, November 19, 1966	Geology Production Technology Non-ferrous Metallurgy	Thermodynamics and Heat Engines Size Reduction, Mixing and Separation Telegraphy and Telephony
Monday, November 21, 1966	Railways General Mechanical Engineering	Hydraulics and Hydraulic Machinery
Tuesday, November 22, 1966	Irrigation Engineering Refrigeration Line Communication Gas Engineering Mining Geology Industrial Metallurgy Antenna and Wave Propagation	Harbours and Dock Drilling Engineering Television Utilization of Electric Power Principles of Heat Transmission and Furnaces
Wednesday, November 23, 1966	Metallurgy of Iron and Steel Industrial Administration	Water Power Engineering Electrical Measurements Heat Treatment of Metals and Alloys
Thursday, November 24, 1966	Public Health Engineering Railway Locomotives and Rolling Stock General Electronics Refrigeration and Air-Conditioning Mine Economics Electrometallurgy and Hydrometallurgy Electronic Measurements	Thermal Power Engineering Servomechanisms
Friday November 25, 1966	Town Planning Automobile Engineering High Frequency Currents Chemical Works Organization and Management Metallurgy and Assaying Fuels and Furnaces Industrial Electronics	General Electrical Engineering
Saturday, November 26, 1966	Architecture Air-Conditioning Radio Communication Materials and Mechanical Construction of Chemical Plants Mine Design and Planning Metallurgical Thermodynamics Radio Communication Systems	Soil Mechanics and Foundation Engineering Aerodynamics Hydro Power Engineering Metallurgy Mine Organization and Management Engineering Metallurgy Audio Frequency Engineering
Tuesday, November 29, 1966	Production Technology and Industrial Engineering Principles of Semi-conductors and Transistor Circuits	Agricultural Engineering Thermodynamics Carrier Current Engineering
Wednesday, November 30, 1966	Principles of Line and Radio Communication	

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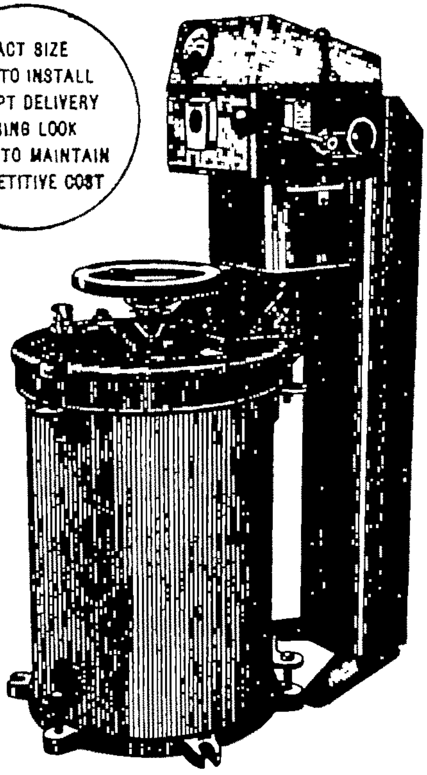

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